FOOD OR FAMINE

THE CHALLENGE OF EROSION

BY

WARD SHEPARD

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To my wife

JEAN KEY SHEPARD

in grateful acknowledgment
of her invaluable advice and
encouragement in my work

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Vienna, Va.

WARD SHEPARD

Table of Contents

Illustrations

FOOD OR FAMINE

The Challenge of Erosion

1

Erosion and Hunger

CAN civilization conquer soil erosion before soil erosion destroys civilization?

A few elementary facts that have come to the fore in the past few years throw this question into high relief as one of the most fundamental problems confronting mankind. For the kind of answer we give to the challenge of world-wide man-made soil erosion will, in the next few generations, spell the difference between food and famine, between a civilization of stability, vigor, and economic balance, and one with a gaudy excrescence of technology and industrialism superimposed on a rotting foundation.

The elementary facts, important to every living human being whether urban or rural, are these: The world's population has expanded enormously in the past century. It is likely to continue to expand, vigorously. With a reasonably durable peace, nothing can hold back the industrialization of the "backward" races; and a new industrial revolution—this time of world extent and with increasing socialization of production—will precipitate a new upsurge of population.

But there will be a basic difference between the old industrial revolution and the new. The enormous human fecundity that was released by Watt's invention of the steam engine was nourished on the soils of new continents—the Americas, Africa, and Australia. European men migrated to every nook and cranny of the world, and with plow and ax harried the earth to

feed the spawning populations of the teeming, smoking new cities. They mined the fertility of the earth to grubstake the machine age. But the cold modern fact confronting the world is that population is catching up with the potential food supply. Aside from the tropics, where the soils present an unsolved and possibly insoluble technical problem, there are no new continents left to exploit. The virgin soil that can still be brought under the plow is only a small fraction of what is already in use.

A surprising shortcoming of the earth's surface is the remarkably small proportion of arable land. Of the total land surface of the world, roughly 11 percent is in fields and pastures, according to a necessarily rough estimate by the United States Soil Conservation Service. In acres that means only four billion acres out of the earth's total land surface, which measures out to only two acres of food-producing land per capita for the world's population. Those two acres would mark a precarious limitation on man's future security even if they were husbanded with the utmost protective skill and ingenuity. Quite the contrary is true.

The bulk of the food-producing land of the world is being depleted in fertility and ravaged by erosion. Despite the brilliant advances of agricultural science, the productivity of the world's soils in output per unit is slowly diminishing. Mankind is fighting a slow retreat before the gathering forces of famine. An ominously and swiftly increasing process of soil destruction is undermining the foundations of our shaky civilization. Beginning as the sapping of soil fertility—a world-wide overdraft on the living richness that nature stored in the topsoil through endless eons—it ends in what can only be described as a new, man-made, cataclysmic geologic era, in which our food-producing soils are being swept into the rivers and seas. Armed with machinery and industrialism, modern man is devastating the farms, the grass-lands, and the forests of most of the world. In the long evolutionary chain of life, he is the only creature who

has achieved the dubious distinction of being able to destroy nature's harmony and fecundity on a cosmic scale.

This "conquest" of nature is, however, a short-lived one. Man, in truth, does not conquer nature. At best, he has the privilege of cooperating on terms and conditions set by nature. That is, he has that privilege if he is sufficiently clever to learn enough of nature's ways to enter into a two-way bargain. Nature holds the whip-hand. Everywhere she is in revolt against man's aggression. Erosion, floods, droughts, the destruction of great land masses, the violent disruption of whole river systems —these are nature's weapons against the impious creature who dares rob her riches without replenishing them.

WAR AND EROSION, TWIN SCOURGES OF CIVILIZATION

A philosophical cynic, viewing modern man as the end-product of a half million years of evolution and ten thousand years of civilization, might point out that he has signally failed to master either of his main jobs: making peace with his fellows or making peace with nature. He might further suggest that both failures stem from the same cardinal sin, the sin of exploitation. A crude and aggressive urge to mastery and dominion, and a blind ignoring of the way of cooperation and mutuality have led to the exploitation of man by man and of nature by man. Cooperation and mutuality constitute the dominant aspect of the life of nature; and, if man is to survive, they must dominate human world society and man's relation to the nature world in which he is embedded.

Indeed, peace with nature, if civilization is to survive, is of the same urgency as peace among men. Modern man has perfected two devices, either of which is capable of annihilating civilization. One is total war; the other is world soil erosion. Of the two, soil erosion is the more insidiously and fatally destructive. War disrupts or destroys the social environment, which is the matrix of civilization. Soil erosion destroys the

natural environment which is its foundation. War is more spectacular: it topples "cities and thrones and powers." But these things are "expendable" and replaceable. Soil erosion, which virtually throughout the world is sapping and gutting the limited soils on which some two billion human beings depend for their daily bread, reaches a stage of irreversible process where man and his works are buried under the drifting sands of oblivion.

So far has the disaster of soil erosion gone in virtually every continent that the reconstruction of the world's broken-down soils and river systems is the most gigantic and complex economic task confronting men. If war and soil erosion, through the next two or three generations, strike up an unholy alliance, man will be a doomed species. If all the world's energy and creativity are poured into the cauldron of total war, there will be little or no social energy to devote to the imperative but difficult world agricultural revolution which alone can make secure the soils and the food supply. In fact, war will hasten the already swift process of soil destruction, for war puts an unprecedented strain on the soil. World-wide hunger and famine and depopulation would be the inevitable sequence in the linkage of these two scourges.

THE GOLDEN AGE OF ABUNDANCE

Since the end of the Napoleonic Wars, the world has had a larger food supply than it ever had before. The nineteenth century was the golden age of abundance. Except for this relatively brief period, food has been man's chief preoccupation through his long, precarious history and prehistory. This golden age of abundance is drawing to an end; probably well before the end of this century food will again become the most pressing economic problem. Indeed, it is already recognized that approximately three-fourths of the human race are underfed. The modern scientific vision of adequate and abundant

human nutrition will remain purely visionary unless the world's scientific and administrative genius are brought to bear against declining soil fertility and increasing erosion.

Two things made the nineteenth century an era of spectacular abundance of food. One was the revolution in European agriculture that occurred at the close of the eighteenth century. The spectacular industrial revolution, which coincided in time with the agricultural revolution, has obscured the fact that the one could not have developed without the other, for the swiftly increasing masses who fed the machines had to be fed in turn. The Middle Ages were always on the verge of starvation because they made no progress in the art of maintaining soil fertility. Under the wasteful and ineffective "three-field" system, a third of the land always lay fallow, in a vain effort to "rest" and rejuvenate it. Almost nothing was known about crop rotation. The agricultural revolution at the close of the eighteenth century rapidly substituted good crop rotations for the medieval system of fallowing, and even more important, shifted from a soil-depleting grain economy to a soil-building livestock economy.

The agricultural revolution not only greatly increased Europe's food production, but gave an unparalleled stability to her soils by devoting a high proportion of them to permanent improved pasturage. This inherent stability and balance have been maintained despite two world wars and the immense growth of European population. But soil stability in Europe was purchased at the expense of the ruthless exploitation of the soils in the new continents. For even more important than the agricultural revolution in feeding the new masses fathered by the machine age, was the European colonization of the rich new fertile lands—the Americas, Africa, and Australia—and the opening up of the black lands of Russia, coincidentally with perfecting machine exploitation of the soil and rail and ocean transport of food crops to the ends of the earth.

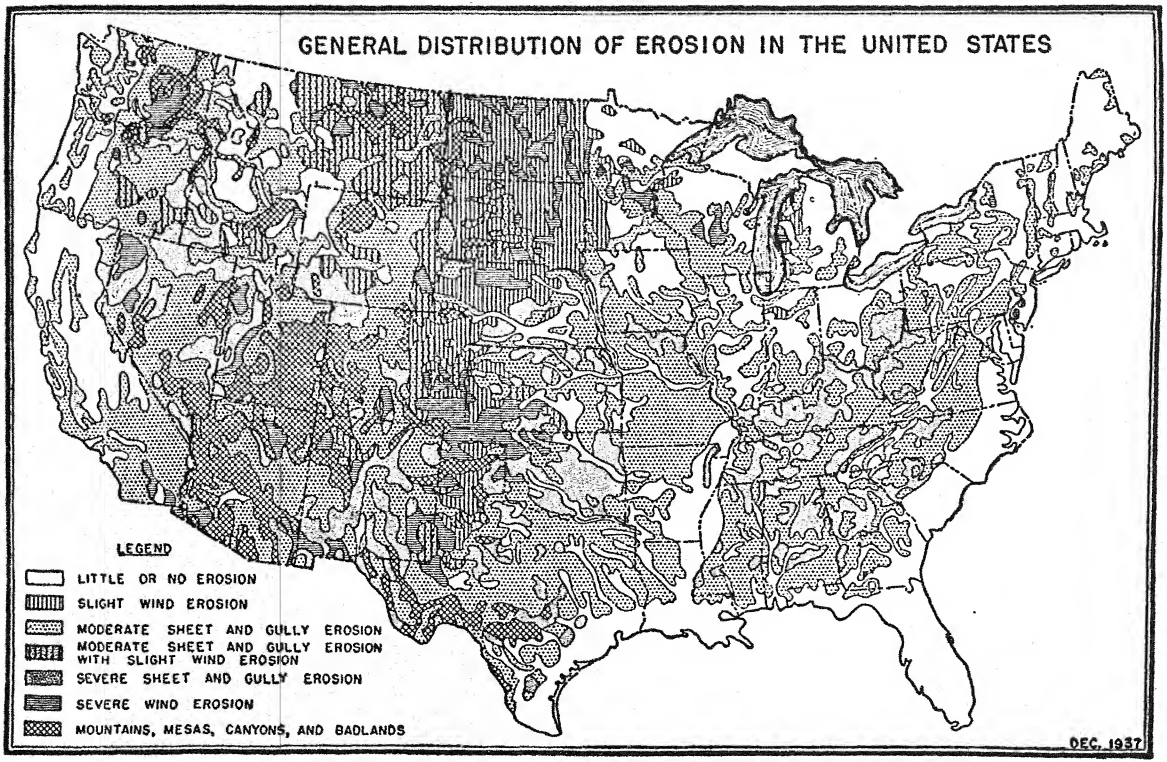
With machine tillage and rapid transport, the vast new lands

became the granary of the world. Their produce could be quickly moved to feed the swiftly growing industrial population of the capitalist countries or to alleviate famine in India or China. Under the spur of the industrial revolution, the nineteenth century witnessed the most prolific population growth in history; but the new agriculture, the new machines, and the new lands made food seem almost as abundant and limitless as air or water. The Malthusian law of the pressure of population on food became, or seemed to become, a dead letter.

Even today the ominous basic facts about the future world food supply are masked behind a puzzling paradox. There is a growing national and international dilemma over the disposal of "surplus" food crops, with drastic internal programs of curtailment and artificial scarcity and with the growing need of international quota systems to apportion fairly the market among different producer nations. But in the face of these "surpluses" is the widespread world malnutrition and undernourishment revealed by medical science, even among the most advanced nations. This seeming paradox between overabundance and malnutrition, however, is not an indication of limitless soil resources.

Many of the "surplus" crops like wheat and cotton are the fruit of an exploitative one-crop agriculture that is wrecking the world's soils; and in the face of widespread malnutrition, these surplus crops are of little significance in their bearing on the world food potential. Much more significant is the fact that the per-capita acreage of arable land is already low. More important, it is being steadily reduced by erosion.

The war has revealed a most significant fact about the world food supply. Contrary to popular belief, there has been a substantial increase in world food production over any preceding period. Food rationing, which has tended to democratize the distribution of this increased supply, has shown that the present food-production capacity of the world is sufficient to give only a moderately good diet to the total world population.


GENERAL DISTRIBUTION OF EROSION IN THE UNITED STATES
LEGEND
LITTLE OR NO EROSION
SLIGHT WIND EROSION
MODERATE SHEET AND GULLY EROSION
MODERATE SHEET AND GULLY EROSION WITH SLIGHT WIND EROSION
SEVERE SHEET AND GULLY EROSION
SEVERE WIND EROSION
MOUNTAINS, MESAS, CANYONS, AND BADLANDS
DEC. 1937

Rationing has for once given the mass of mankind almost enough to eat. The increasing socialization of economic production, which is everywhere the dominant trend of the twentieth century, will give vast multitudes of men an increased purchasing power that will put an enormous strain on our dwindling soil resources. This constitutes the world's number one economic problem. It is not only the basic fact confronting agricultural policy, but is the limiting factor that will dominate and control industrialization. Men must be fed before the machines can be fed.

THE DISCOVERY OF SOIL EROSION

The discovery of the vast extent and the destructive incidence of soil erosion is very recent. Men have indeed been long, though rather vaguely, aware of it. Plato gives an amazingly accurate technical account of deforestation and erosion in the mountains of Attica, which destroyed the farms of the plains and drove the Greeks to become seafarers and traders. Washington and Jefferson were both aware of destructive erosion on the eastern seaboard and in the Piedmont of the United States. But it was not until the emergence of the United States Soil Conservation Service in 1933 that either America or the world began to grasp the ominous magnitude and menace of man-made erosion as a world phenomenon.

Where observed at all, soil erosion had been dismissed by most men as a natural event, unfortunate no doubt, but a geological process. Under the leadership of Hugh Hammond Bennett, who had studied soil erosion all his life and now became the apostle of a holy war against it, the Soil Conservation Service, rapidly evolving into nothing less than a fundamental agricultural revolution, set out to find the facts of erosion and, more important, to develop a strategy to fight and defeat it. Fortunately, just when the new and militant agency was get-

ting onto its feet, it was aided and abetted by a series of God-given calamities in the form of searing droughts, stupendous floods, and continent-darkening dust-storms that impressed on men's minds, to the four corners of the earth, the fury of the swiftly spreading revolt of nature against man's crude efforts of mastery. The Dustbowl not only woke up America, but woke up the world.

But the Dustbowl was only an overt and obvious symptom of the largely hidden ruin that was overtaking the good earth of the fabulously rich American continent and that men soon found was overtaking the other continents. Setting out on a continent-wide survey, the Soil Conservation Service found that man-caused erosion was far more widespread than even the experts had thought. They found it in progress on more than half our land surface—on more than a billion acres of the less than two billion acres in the continental United States.

They found that already over 100 million acres of our best crop-land had been irremediably ruined for further cultivation. Of the total crop-land now in use—somewhat more than 400 million acres—about 150 million acres had been so severely damaged as to make farming difficult or unprofitable. These figures relate only to arable and pasture-land in farms. An even more destructive and critically dangerous erosion has swept over the western grass-lands of the Great Plains and intermountain plateaus after fifty or seventy-five years of overgrazing by livestock and futile and mistaken efforts to subdue these lands to the plow. In these vast semi-arid regions, nature's balance is exceedingly precarious and is easily overturned by even a moderate misuse. Nowhere in America and almost nowhere in the world is the stupendous breakdown of great land masses and river systems more advanced, and in few parts of the world has man been more decisively defeated by nature than in the grass-lands.

On our third great category of land—forest-land—America has met the same decisive defeat at the hands of nature. For

beyond a small remnant of virgin forest still remaining, mostly in the western mountains and the Pacific Northwest, the forests that were left after all the better soils had been cleared for farms are in the grip of an overwhelming process of degeneration induced by fire and the ax and the nihilistic philosophy that we can confiscate nature's bounty without the reciprocal obligation of replenishing it.

We can measure the cumulative consequences of this continental orgy of destruction in another way. From our farms and grass-lands alone, man-made erosion is moving over three billion tons of soil every year down into our rivers and reservoirs and out to sea. This is the rich topsoil that contains, in minerals and humus, the great reserves of plantfood standing between man and famine.

But the tale of wastage does not end with the gutting of the soil and its fertility. For the magnitude of the erosional debris measures also the magnitude of the loss of the surface water that is required to sweep it seaward. In a state of nature or under good soil husbandry, rain-water goes into the soil to nourish plants and to slowly feed wells, springs, ponds, creeks, and rivers. The loss of surface water through man-made erosion is desiccating the earth and wasting for human use a substantial percentage of the total rainfall. Thus erosion is wasting our basic economic goods on a cosmic scale—soil fertility, the soil itself, and the life-giving waters.

These, however, are only the dramatis personæ in the tragic breakdown of land and water resources. The full fury of the destructive process is revealed in our great river systems. With their channels clogged and ever rising by the deposit of our wasted soils and soil fertility, our rivers are becoming more and more incapable of safely carrying the increasing quantities of wasted surface water. Our engineers, still bemused by the fallacy that man can conquer nature, dream of restoring our broken-down river systems by the simple expedient of erecting

gigantic flood-detention and silt-detention dams. This is a naive oversimplification of the problem. All the river barriers, in the form of dams and dikes, that man can furiously construct to repair the consequences of his own folly in raping the earth are puny and insignificant compared with the cosmic forces of destruction he has unleashed over all the land. For the engineers ignore the most significant aspect of their problem, namely, that nature herself, violently reconstructing entire watersheds in an effort to cope with the surplus runoff, has carved over 200 million gullies in the United States. This gigantic gully system, rapidly extending in a complicated network over whole regions, is nothing less than the beginning of a new man-made geologic era, in which the plains and the highlands are being rapidly carved and sculptured, and transported into our river valleys. Gully-forming is the final stage of erosion, precipitated by a long preexisting stage of sheet or surface erosion, in which the topsoil is insidiously removed by surface runoff. A uniform characteristic of erosion is that it gathers headway at a geometrical rate of progression. Gully erosion starts when enough soil is being transported by enough water at a swift enough rate to cut and abrade deep channels.

The vast extent of sheet erosion, the gigantic and rapidly growing gully system—both doing their deadly work at a geometrically increasing rate—make the isolated treatment of our main river systems futile. The disease of our sick rivers must be treated at its source—the sick land. Otherwise the most elaborate and costly engineering works are doomed to be overwhelmed under the debris of a wasted land.

WORLD SOIL EROSION

If America's tragedy of soil erosion and resource wastage has been spectacular and also, to thinking men, humiliating, our attack on the problem has been no less spectacular and also, so

far as it has gone, an *amende honorable* for our past blindness and waste. The simultaneous attack by the Soil Conservation Service on the disease of erosion at its source and by the Tennessee Valley on the integrated control of a whole river system, attracted a curiously responsive interest in the far corners of the earth. There was an instinctive recognition that here were revolutionary upward surges in man's intellectual and moral stature, in man's relation to the world of nature in which he is imbedded, but above which also, to a limited degree, he is capable of rising.

The wider social significance of these great New Deal enterprises will be dealt with later. Here it suffices to say that one immediate world reaction to the American experience was to make the nations of the world take stock of their own soil resources. Probably no other country has had anywhere nearly so intensive a stock-taking as the United States; but nevertheless many other countries have repeated the discovery of America, namely, that once a stock-taking is undertaken, it is discovered that erosion, because of its insidious nature, is far more widespread than was realized.

One of the most important results of this world-wide curiosity is the first comprehensive study of world erosion, made by two English scientists, G. V. Jacks and R. O. Whyte.[1] This study in itself was made possible by the fact that many governments in many parts of the world, startled by the American experience and by the warnings of their own experts, were beginning to bestir themselves on the hitherto little noted disaster of soil erosion. One of the general conclusions of these two English men of science constitutes a somber warning to the statesmen and peoples of the world:

". . . As the result solely of human mismanagement, the soils upon which men have attempted to found new civilizations are disappearing, washed away by water and blown away by wind. To-

[1] Published in England as *The Rape of the Earth;* in America, as *Vanishing Lands,* Doubleday, Doran and Company.

day, destruction of the earth's thin living cover is proceeding at a rate and on a scale unparalleled in history, and when that thin cover —the soil—is gone, the fertile regions where it formerly lay will be uninhabitable deserts. Already, indeed, probably nearly a million square miles of new desert have been formed, a far larger area is approaching desert conditions and throughout the New World erosion is taking its relentless toll of soil fertility with incredible and ever increasing speed. Science produces new aids to agriculture —new machines that do the work of a score of men, new crop varieties that thrive in climates formerly considered too harsh for agriculture, new fertilizers that double and treble yields—yet taken the world over the average output per unit area of land is falling. There is a limit to the extent to which applied science can temporarily force up soil fertility, but there is no limit except zero to the extent to which erosion can permanently reduce it. A nation cannot survive in a desert, nor enjoy more than a hollow and short-lived prosperity if it exists by consuming its soil. That is what all the new lands of promise have been doing for the last hundred years, though few as yet realize the full consequences of their past actions or that soil erosion is altering the course of world history more radically than any war or revolution. Erosion is humbling mighty nations, reshaping their domestic and external policies; and once for all it has barred the way to the El Dorado that a few years ago seemed almost within reach." [2]

Jacks and Whyte review the well-known evidence of the decline and fall of ancient civilizations through the destruction of soil fertility and the wastage of erosion. The classic examples are the once mighty, now buried civilizations of Babylonia and Assyria, and the colossal man-caused destruction of the once rich loessial soils of the vast regions of northwest China, whence proceed the floods of the Yellow River, the most destructive of all human cataclysms. Less well known is the fact that erosion has destroyed or sapped all the Mediterranean civilizations, ancient and modern, from Athens and Rome to Italy and Spain, to say nothing of the formerly fertile plains of North Africa,

[2] *Op. cit.*, pp. 2-3.

which once supported a no less mighty power than Carthage. Many of these lands are "dead and done for":

". . . the lion and the lizard keep
The courts where Jamshyd gloried and drank deep . . ."

What modern men are interested in is what is happening to the soils of modern countries, where civilization is still a going concern and still has a chance if it can simultaneously conquer war and erosion.

In all the newer continents, the story of erosion is similar in its physiographic details, but differs in the social and economic causes that precipitate it. In South and East Africa, where erosion has reached the critical proportions it has attained in the United States, the main causative factor is that the white colonizers have forced the numerous native peoples into an ever more restricted area, which has led to an immense pressure of population on the land. In North and South America this causative factor operates, though in a lesser degree, through the concentration of the Indian peoples on insufficient land of the less productive and more erodible type. But in the Americas, the bulk of the erosion has been caused, not by the "backward" peoples, but by the exploitative, commercial agriculture developed by the European colonizers to meet the food requirements of the expanding world population.

EROSION IN SOUTH AMERICA

Preliminary and rather fragmentary data presented at the first meeting, in 1942, of the newly formed Pan-American Commission on Conservation, show that erosion is prevalent in virtually every country of the continent. One great region of erosion is the mountainous highlands of Bolivia, Ecuador, and Peru, where the Indian population, deprived of the use of the lowlands, is forced to cultivate excessively sloping land. Ero-

sion is acute on the wheat-lands of Chile; and the pampas of the Argentine have a wind-erosion problem comparable to that of our own Dustbowl, and for the same reason—overgrazing and the plowing of the grass-lands to grow wheat. Water erosion is also prevalent in the agricultural regions of the Argentine and throughout Uruguay, where overgrazing of livestock has widely depleted the soils, which are peculiarly susceptible to erosion.

In Brazil, both in the highlands of the northeast and in the Amazon basin, erosion is recognized by the government as a serious evil; and so critical is the situation in Venezuela that the government, with the aid of American experts, has surveyed the damage with a view to remedial measures. In Colombia, the coffee plantations show excessive erosion, as do also the overcrowded farms of the highlands. Information for Central America is less detailed; but it is known that there is widespread erosion in the highlands of Mexico, partly due to the cramping of the Indian population on insufficient lands and partly to overgrazing and deforestation. While erosion in Central and South America as a whole has not reached the magnitude it has reached in the United States, there is no question that it is a hemispheric problem.

AUSTRALIA AND NEW ZEALAND

The great Australian wheat-lands are the prey to acute water erosion; and in the semi-arid and frequently drought-stricken grazing lands that border the great central desert, wind erosion is as critical as it is in the Great Plains of the United States. Deforestation in the mountains has also created a flood and siltation problem in Australia. In New Zealand, which is primarily a grazing country, there has been extensive deforestation to make way for pasture-land, which, in turn, over large areas has been heavily overgrazed.

AFRICA

The continent of Africa ranks even ahead of North America, according to Jacks and Whyte, in the extent and severity of erosion. Although various governments—particularly that of South Africa—have bestirred themselves over the problem, erosion is gathering headway at a swift pace throughout the continent. In many places, the native peoples have been crowded into diminishing land areas by European colonists and thus forced to overcultivate the soil.

Extensive deforestation to clear patches for temporary native agriculture is in many places a serious causative factor. Over great areas of veldt, overgrazing, and particularly overconcentration of livestock near water-holes, has caused severe devegetation and erosion. The burning of the veldt is another potent cause of erosion. Throughout much of Africa, and especially around the borders of the Sahara Desert, the disturbance of natural ecological conditions has been so profound that true desert conditions are advancing over once fertile farm and pasture-lands. The progression is swift from devegetation to sheet and gully erosion and thence to desiccation and the lowering of the ground water level.

In South Africa, General Smuts has stated, "Erosion is the biggest problem confronting the country, bigger than any politics." On the African continent as a whole the problem of erosion control is rendered formidable by the great diversity of governing powers and of native tribes, with their deeply entrenched land-use customs.

Thus the new countries on which the world depends for much of its wheat, mutton, beef, wool, and coffee are all confronted with the rapid dwindling of soil resources and a potential sharp decline in total production. But it would be misleading to infer that the newer countries are the only sinners in soil destruction. It is known that erosion is very extensive and

acute in the great wheat-producing black lands of Russia and in the vast Eurasian grass-lands. In India, too, the immense increase in population under British rule has created such a pressure of population on the land that erosion has been spreading with startling rapidity in recent times.

Looking at the world's soils and natural resources in the large, they are in general and with few exceptions characterized by similar degenerative processes, which may be classified as follows:

(1) In humid regions, water erosion is destroying sloping lands by virtue of poor methods of tillage and by overgrazing of pastures.

(2) The cultivable grass-lands—the prairie soils of the Americas, Australia, Africa, and Russia—are being depleted by one-crop farming, notably wheat, and by wind and water erosion.

(3) Semi-arid grass-lands in the Americas, Eurasia, Africa, and Australia have been severely devegetated by overgrazing, with intense wind and water erosion that in many regions is producing, or threatening to produce, true desert conditions.

(4) The bulk of the world's forests are being destructively exploited, not over 12 or 15 percent of the total forest area being under scientific management.

(5) In all these countries, poor tillage, overgrazing, and deforestation are wasting vast quantities of surface water by permitting it to rush into stream channels and out to sea instead of being absorbed into the soil by well-kept vegetative cover. This wastage causes dessication of the land, the disruption of rivers and valleys, and an increasing menace to immense potential sources of hydroelectric energy.

TRADITIONAL AGRICULTURE CANNOT COPE WITH SOIL EROSION

The array of cumulative evidence is overwhelming that in most parts of the world agriculture and other land use as now organized is incapable of coping with the destructive and

interacting complex of forces that, for convenience, are lumped together under their main precipitating factor, soil erosion. Indeed, Jacks and Whyte conclude that northwestern Europe is the only large land mass in the world where a reasonable degree of soil stability has been achieved. Moreover, world agriculture as it is now organized is not able to meet the world's nutritional needs, and, based as it is on soil depletion, will become less and less able to meet those needs. This is an outstanding economic and cultural problem confronting the human race. In its vast implications, it ranks in magnitude with the problems of war, peace, revolution, and industrialization.

The extent of malnutrition is not accurately known; but enough is known to indicate that well above half the human race are undernourished in either quantity or quality of food. The main diet of the bulk of mankind is cereals, and there is an aggregate enormous deficiency in proteins such as meat, eggs, and cheese, and protective foods such as milk, vegetables, and fruits. Says L. B. Pearson, chairman of the United Nations Interim Commission on Food and Agriculture:

"Millions of men, women, and children are haunted by the constant fear of starvation and millions more are handicapped from birth to death by hunger and malnutrition. . . . Hunger is a menace to peace, security, and human welfare. . . . Modern scientific knowledge has made such sufferings unnecessary and intolerable."

Our primitive land husbandry, with its attendant soil destruction, is, of course, not the sole cause of malnutrition. Ignorance and dietary prejudice play an important part. Even more important, the masses of men are too poor to buy the food they need. These obstacles to adequate nutrition can be conquered. The war has, indeed, made people everywhere conscious, as they never were before, of the essentials of a good diet. It has also begun to teach them that competent social organization can abolish unemployment and poverty and that the

democratization of the economic process will shift the world economy from one of scarcity to one of abundance. But the peoples of the world are only beginning to sense dimly that soil exploitation, if continued, will make impossible the goal of abundance which is the necessary foundation of a democratic civilization.

ONLY CONSERVATION CAN SOLVE FOOD PROBLEM

The food problem can be solved only in terms of the soil problem. These two problems are indivisible and inseparable. The only kind of land husbandry that can prevent soil erosion and depletion also requires the intensive crop diversification and animal husbandry that provide the essentials of good nutrition.

It is now feasible by well-tested technologies of soil conservation recently developed in the United States to control soil erosion, rebuild and stabilize soil fertility for permanent production, and by these methods to greatly increase and highly diversify food production. The sum of these technologies may be defined as ecological engineering, that is, a system of land management that makes use of nature's methods of soil holding and soil building. By a sort of retribution for her sins, America, who has more severely depleted her natural resources to grubstake the industrial revolution than any other modern nation, has made great advances in the new land engineering and in the social mechanisms necessary to put it into effect, and is consequently prepared to assist many other nations affected with this problem.

Conservation, in essence, is good land husbandry, not in the traditional sense but in the modern scientific sense. In that sense it is a complex and integrated technology that requires far-reaching social action and bold managerial skill to put into effect. This new land husbandry, if agriculture is to meet its future social responsibility, must ramify over the habitable

earth, requiring the intelligent cooperation of all men who work with the land and the inspired guidance of science and government. Modern man has reached a historic moment when he must organize an effective attack to rebuild this basic economy, or face a definitely deteriorating civilization.

CONSERVATION A BASIC INTERNATIONAL PROBLEM

This study deals primarily with the conservation problem of the United States, but in such a way that the main conclusions are widely applicable. For it approaches conservation not as a mere problem of technology but as a problem of social engineering. It raises and attempts to answer the question, What kind of cooperative social action must be undertaken to rebuild and stabilize our land and water resources in order to keep the good earth permanently fruitful? In seeking an answer to this question, it will be found, the author believes, that the basic principles of social action applicable to the United States are, with due allowances for varying traditional and institutional patterns, applicable to other countries.

Conservation is more than a national concern. It is an international concern. The unchecked depletion of the world's soils and the consequent diminution of the world's food supply will become a more and more pressing invitation to wars of conquest and revolutions of hunger. World agriculture has been shattered by the war. It must be rebuilt to feed a starving world. And while it is being rebuilt, let it be done from the ground up, on the principles of conservation. It is essential that the statesmen of the world, in dealing with this fundamental human issue of food, shall recognize the world soil crisis and confront boldly and intelligently the imperative need for concerted action for a world conservation program. Peace with hunger will not be peace for long. Freedom from want cannot be founded on the despoliation of the living soil. Civilized man cannot with impunity violate the fundamental laws of his

PLATE 1. The contour or level furrow is as basic and elemental an invention as fire or the wheel.

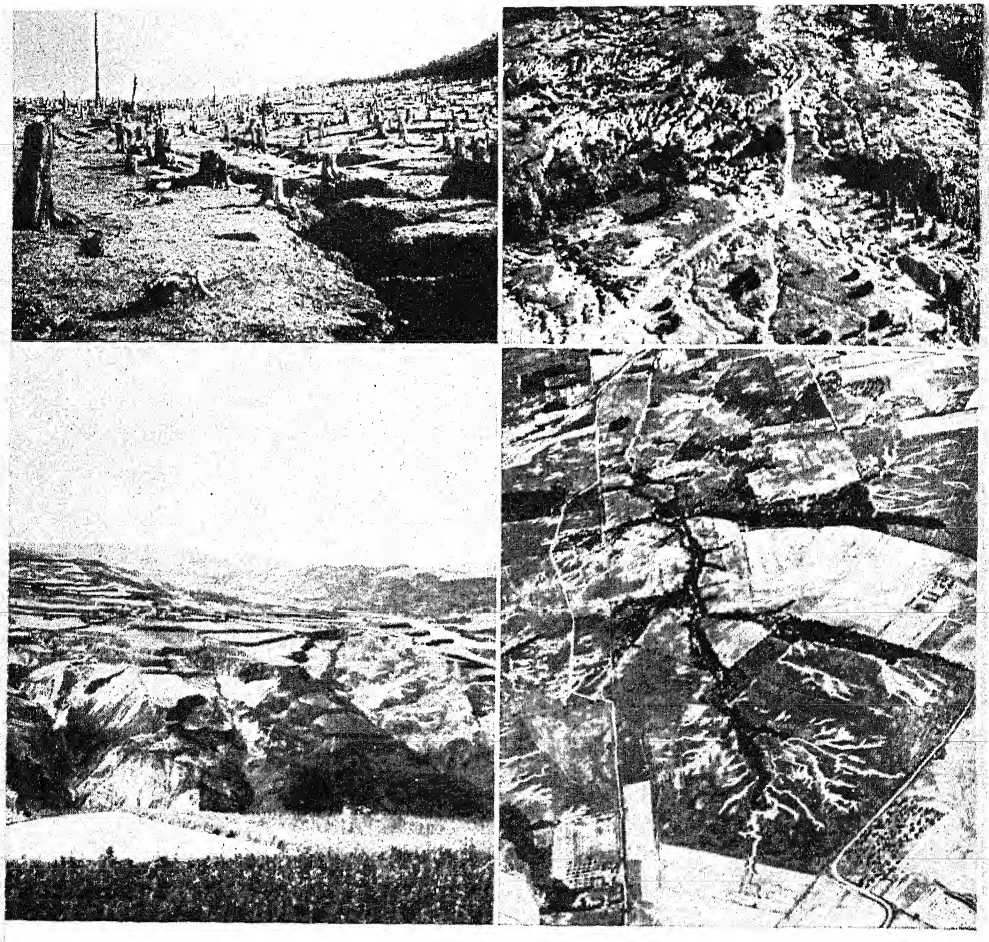


PLATE 2. Soil erosion throughout the world is breaking down great land masses and river systems, in a new, cataclysmic, man-made geologic era. Colorado, Mississippi, China, Texas.

physical existence. Conservation is one of the greatest of all challenges facing the statesmanship of nations and the vision of peoples.

The United Nations Conference on Food and Agriculture recognized the importance of conservation in its Final Act and in the recently promulgated constitution for the proposed permanent United Nations Food and Agriculture Organization. But recognition and action are two different things. It remains to be seen whether the Permanent International Commission proposed by the Conference will come effectively to grips with this most basic of all agricultural problems. For conservation requires not only revolutionary changes in traditional methods of agriculture: it requires revolutionary changes in the relation of government to agriculture, in the methods of promoting truly scientific agriculture, and in methods of administration and finance. Men indoctrinated in obsolete methods frequently resist change. There are vested scientific and intellectual interests that oppose innovation. Yet, confronted with a world food crisis, it is essential that agricultural technicians, administrators, and leaders obtain a clear view of their responsibility of getting to the roots of the world soil crisis.

NEEDED: A WORLD REVOLUTION IN AGRICULTURE

In the development of machine technology, of mass production, and of vast power resources, the world has made notable advances in applying the methods and fruits of science to human welfare. The advance of economic democracy will make these benefits far more widespread and abundant. But there has been no comparable advance in agriculture. For despite the brilliant achievements of agricultural science over the past century, world agriculture, even in most of the advanced countries, is primitivistic in its basic concepts. By and large, agriculture has not mastered the art either of maintaining soil

fertility or of keeping the soil in place; still less have graziers mastered the arts of grass-land management or lumbermen the arts of forest management. A revolution in world agriculture and land use comparable in scope and scientific precision with the modern development of the industrial revolution is dictated by the basic nutritional needs of expanding world population. The coming agricultural revolution will be to the world's food supply what the industrial revolution has been in the abundance of industrial products.

Two difficulties confront this revolution. One is that most of the world's soils are owned by small farmers and peasants. Approximately three-fourths of the world's population live on the land. Moreover, peasants and farmers are notoriously conservative, individualistic, and traditional. This presents an enormous problem of social organization, but a problem that is not insurmountable as will be demonstrated later in the amazing history of the American soil conservation districts.

A second difficulty is that the methods of promoting scientific agriculture are largely immature and wholly inadequately organized. In modern mass production, a vast technological skill and wisdom are fused and dovetailed into an integral process whose amazing potentialities of output for a given unit of human energy have not even yet been reached. In agriculture, the traditional methods of diffusing agricultural science have evolved no comparable synthesis and integration of the intellectual concepts underlying scientific management. Scientific methods of land husbandry reach the farmer and the peasant, if at all, in piecemeal, unrelated fragments. But scientific land management, to fit man's use of the soil to the ecological requirements of nature, demands the same fusion and integration of ideas and methods that scientific management in mass-production industry demands.

There are, however, two conspicuous large-scale exceptions to this backwardness in the application of agricultural science. One is the collective farms of Russia, where individual owner-

ship has been abolished and the farmers become employees of technical managers. The other is the American self-organized and self-governing soil conservation district, where the individual farmers cooperate with the conservation technicians in working out completely integrated systems of land management. There are strong reasons to believe that the American system of individual ownership, combined with expert guidance in integral management, will in the long run be at least as productive as the collective farms of Russia, while preserving the highly cherished American ideal of the family farm and of individual enterprise.

The shift from soil exploitation to conservation will thus require a veritable revolution not only among farmers, peasants, and other land owners, but among agricultural scientists, educators, and statesmen in organizing agriculture to cope with the problems of conserving soils and soil fertility, and of stabilizing grass-lands, forests, and waters. But even that is only part of the whole picture. For nature is not a collection of fragments, but an equilibrium of dynamic and living forces. Individual parcels of land are merely units in a larger natural unit. Each individual farm or other land unit must be organized as a balanced entity, according complete respect to the laws of nature; but also every valley and drainage basin, up to the largest river system, must be treated as a unit, with a balanced interplay and use of the interrelated factors of soils, plants, animals, and waters.

GLOBAL ORGANIZATION OF CONSERVATION

Quite obviously, this gigantic task is beyond piecemeal individualism. Nowhere has laissez-faire individualism more completely and disastrously broken down in the modern world than in the use and abuse of our soils and natural resources. In no other aspect—not even in war—has civilization been so ravaged by drift, traditionalism, do-nothingism, and the dis-

organization of science; and in no other aspect of human life is state intervention more imperatively dictated. Government must intervene to protect the world's soils, its food supply and forests, its waters and rivers. It must provide a thorough, integrated scientific service to land owners looking to the universal application of ecological land management. It must, where necessary, invoke public regulation to prevent soil abuse. It must organize the unitary control and development of entire river systems and watersheds. It must bear the brunt of repairing past ravages of soils, forests, and river systems. It must organize an adequate system of credit and capital financing for rebuilding natural resources. And it must, where necessary, alter land-tenure systems in a way that will fit land use with the ecology of nature, including a greatly increased public ownership of certain types of land, notably forest and semi-arid grass-land. This book deals with the broad outlines of a global attack on our disorganized lands and waters. It is based on the fundamental assumption that half-measures are not enough, for the only terms on which we can make peace with nature is unconditional surrender—to nature's ways.

2

Natural and Human Forces in the Soil Crisis

THE evolutionary doctrines of the nineteenth century, based as they were on the struggle for existence and the survival of the fittest, have obscured the great fundamental harmonies in the realm of nature. There are, to be sure, conflict and struggle among living forms, but they are subordinate to and a detail in the larger interlocking cycles of natural forces that make life possible and that minister to its needs. We may, if we wish, accept the current scientific skepticism that these harmonies are accidental and purposeless; or we may suspend judgment in the belief that science has as yet hardly even attacked the problem of organization in nature. Whatever our philosophy, we are confronted with the important fact that there is more of cooperation in nature than conflict.

Nature is not only a competition but a cooperation. Among her harmonies there are, to be sure, dissonances (of which man may yet turn out to be the worst if he doesn't watch his step), but there is also a pervasive theme, which is the struggle of life to conquer inert matter. Plants have played the crucial role in this struggle. It is not merely that plants have the divine gift of transmuting sunlight into animal energy, into human thought and imagination. Plants created the fecundity and fertility of the thin earth-crust that stands between man and annihilation—the living soil. Plants tamed rain-water to sink

into the soil, to work instead of wreck. Plants are the guardians of soil and water.

As we gain understanding of the interplay of natural forces that make for life instead of death, we shall be able to harmonize man with nature and create an enduring foundation for civilization. The next great cultural advance of the human race will be to recognize and act upon this basic condition of human life. Nature is both tolerant and exacting, both generous and rigorous. She does not hesitate to brush aside any species of animal that cannot or will not play the game. Yet her bounty is inexhaustible.

The great cycles and rhythms of nature operate like a mighty loom in weaving together the myriad forms of life. Through the mysterious mechanism of the chlorophyll of plants, sunlight weaves a pinch of chemicals, water, and carbon into the numberless beautiful plant forms. The plants in turn give off the oxygen of their absorbed carbon dioxide and yield their stored solar energy to animals and men as food. In the procession of the seasons, the sun evaporates water from the earth and seas, and plants transpire it to the atmosphere, where it starts again on its perpetual cycle to the clouds and back to the earth and the seas. Rains and frost and the roots of plants disintegrate the rocks and form soils. Running water weathers the mountains and levels the plains with transported soils. Forests and prairies evolve complex plant and animal associations, whose individual members, though "competing for a place in the sun," also support and help each other in a veritable household of nature.

In this vast complex of interacting forces, it is the soil that plays the crucial role. The thin layer of topsoil at the crust of the earth—averaging only a foot or two in depth—literally stands between life and annihilation. For it is only by virtue of this rich topsoil that sunlight was able to synthesize the raw materials of life into plant forms and thus lay the groundwork for animal and human societies.

THE SOIL: THE LIVING GUARDIAN OF LIFE

The topsoil is no mere inert mineral substratum in which plants take root. It is a perpetually living, active process where a vast population of bacteria, fungi, insects, and worms are forever at work disintegrating the remains of dead plants and animals into food for living plants and animals. Here, in the humus of the earth's topsoil, is concentrated a large part of all the plantfood elements on earth—carbon, nitrogen, potassium, phosphorus, and other elements. This is the basic capital of life and civilization. It has been accumulated like a gigantic bank reserve through eons of time by the patient collaboration of plants and the minute living organisms of the soil. Ages ago, primitive plants like the mosses and lichens began the slow process of weathering the rocks and storing fertility for successive waves of higher and higher plants, until animals emerged, and the two great branches of life pursued their evolution together.

Thus evolving through the ages, forests and prairies have built up dense, harmonious plant associations which not only have enormous stability in themselves, but which stabilize and keep perpetually fertile the topsoil by virtue of whose vast reserve of food they are able to exist. Plants are jealous guardians of the soil they have created and which in turn nourishes their life. Plant cover is the great tamer and regulator of rain-water after it strikes the earth. The granular, spongy, humus-laden topsoil absorbs great quantities of water, stores it for the use of growing plants, and feeds the surplus slowly into the great subterranean reservoir of ground-water, where it is paid out slowly, through the seasons, into springs, rivulets, creeks, and rivers. Even in heavy rains which overtax the absorptive capacity of the humus, a dense plant cover slows down the runoff of surface water and, more important, renders it powerless to erode and transport soil particles by the binding power of its

roots and by impeding the speed of the running water. Even in torrential rains, the water running off virgin forest or prairie land is virtually clear. Under such conditions, the denudation of soils by geological erosion is so slow and imperceptible that it has to be measured in eons.

CIVILIZED MAN DISRUPTS NATURE'S CYCLE

Plant life is thus the guardian of two of the greatest capital assets of civilization—the stored humus of the soil and the water supply on which food, industry, and commerce depend. By disrupting and in large measure degrading or destroying the natural plant cover of the earth, and by failing to develop artificial plant covers to take its place, civilized man has disrupted this whole gigantic complex of soil, water, and plant life, and substituted chaos for harmony over a large part of the earth. He is steadily exhausting the capital reserve of humus without replacing it. He has set up gigantic and appalling processes of man-made erosion that are destroying the world's soils, choking the rivers with silt, and carrying the fertility of the earth out to sea. He is shunting the rain-water off vast areas of bare, denuded land directly into the rivers, to cause ever more destructive floods. He is robbing the soil of its reserves of water for plant growth and for the great ground-water reservoir that is the regulator of streamflow, and is thus wasting a large share of the water supply and, in effect, reducing the rainfall and desiccating the earth.

This disruption of nature's cycle of life has been going on in many lands, for many centuries. Ancient civilizations have, in fact, been entirely destroyed and buried under the sands of oblivion. But it is only in modern times, with the impact of the machine and the swift growth of population, that the destructive process has reached such vast proportions. Yet there is no necessity for its continuation. It is rooted in ignorance of

the ways of nature and in greed and shortsightedness in using nature's bounty. It is only in comparatively recent years that we have learned enough of the unity and the interrelatedness of the processes of nature and have made sufficient technological progress in simulating nature's ways to be able at last to attack this baffling problem with the necessary strategic concepts. These concepts go far beyond mere technology. They involve nothing less than the systematic reorganization of agriculture and other types of land use on naturalistic principles in a great over-all design aimed at stabilizing the earth's soils, rebuilding their fertility, and conserving and regulating the flow of waters.

MAN'S DESTRUCTION OF NATURE

The steps by which man has broken up the equilibrium of nature are simple. In removing natural vegetation to make way for agriculture, he has failed to develop his artificial plant cultures in a way to simulate nature in holding and building soil. He has used up the stored humus—his ultimate capital—with only half-hearted efforts to restore it. Instead of developing a yearlong protective mantle of cover-crops, he leaves most of the arable soil of the world bare to the destroying elements except in the summer growing season. He runs his plow up and down hill instead of on the level, so that each furrow is a potential gully, and thus invites rain-water to rush down hill, peeling off the rich topsoil with its life-giving humus, developing cancerous gullies that dissect and destroy his fields, and filling the rivers with raging floods and clogging silt. His cattle and sheep graze at will on the grass-lands, weakening, thinning out, and finally destroying the valuable soil-holding and soil-building grasses, and then destroying the soils themselves by water and wind erosion that convert the once verdant prairies, with their richly developed plant associations,

into dustbowls and deserts. With fire and ax he disrupts and destroys the forest, the most complex and highly developed of all the plant associations, and with it the rich accumulations of humus built up through ages. Having disrupted or destroyed the natural habitats of the endless, beautiful diversity of animal species, he does not hesitate to destroy these species themselves, masterpieces patiently wrought out through the cycle of the ages in nature's indefatigable struggle of life against death.

MAN-MADE EROSION A NEW GEOLOGIC PROCESS

One may observe an eroding field or farm without attaching any great significance to man-caused erosion. But if we project our imagination over whole regions gripped by erosion, we begin to glimpse its staggering cumulative effects.

If we visualize the action of millions or billions of tons of water falling over the whole extent of a large denuded watershed, we can begin to understand the enormous sweep of man-made erosion and destructive runoff. Over great land masses, they break down the highly stabilized natural equilibrium between soil, plants, and water, and set up nothing less than a new geologic process. Vast quantities of rich soil material are being transported from the mountains, the foothills, and the plains to the river-beds and out to sea—soil that is inexorably being subtracted from our limited food-producing lands. The broad alluvial bottom-lands of the lesser rivers are being dissected by gullies and ultimately entirely washed away, being replaced by broad meandering beds of gravel and boulders. Billions of tons of water that should be absorbed into the soil for plant growth and for slow subterranean flow into the streams rush, as from a tin roof, into the stream channels and pile up into gigantic, silt-laden floods.

Thus, beginning unobtrusively with devegetation and the exhaustion of soil fertility, soil erosion ends by destroying the

harmonious natural regimen of entire drainage basins and river systems. It is nothing less than the breakdown of whole land and river systems. This destruction is evidenced not merely by the wreckage of wasted land, but by alternate violent floods and low water, by the rapid silting up of river channels and reservoirs, and by the aggradation or building up of river-beds so that they gradually rise above their flood plains and must be contained by artificial dikes. The notorious Yellow River of China, after millennia of erosion of the rich loessial soils of northwest China, flows on a bed high above the densely populated, highly cultivated alluvial plains of the main river valley and periodically breaks its dikes with a catastrophic destruction of property and human life. The Mississippi is in the earlier stages of the same process of aggradation, receiving immense loads of flood-waters and silt from such badly used watersheds as the Missouri and the Ohio. Yet our flood-control engineers, like the Chinese, vainly imagine they can restrain the wrath of the Mississippi floods by dikes and detention dams without looking to the source and cause of the increasingly violent floods and ever-mounting sedimentation.

NATURE HOLDS THE WHIPHAND

Thus, what is roughly and generically defined as soil erosion, is actually a complex series of destructive interlocking processes that substitute chaos for order in the realm of nature and man's use of nature. Man is at war with nature, and nature is in revolt at man. But let us make no mistake. Nature has the whiphand and is using it. Nature can wait and can reestablish her equilibrium, if need be, after man has disappeared, through his own folly, from the scene. Modern man faces the ominous question whether civilization can learn how to conquer soil erosion before soil erosion has destroyed civilization. That is not a rhetorical question.

The geometrically increasing assault on the sharply limited arable soils of the world, combined with the wastage and ruination of our river systems, is spelling itself out in the rapidly shrinking ability of the earth to support human population. In human terms, soil erosion means poverty, depopulation, and decivilization. "The dyer's hand is subdued to what it works in." Men cannot set in motion vast degenerative processes in nature without themselves degenerating. If we translate physical processes into social terms, the ultimate issue of soil erosion is hunger, squalor, poverty, ignorance, the destruction of social vitality, and depopulation.

Soil destruction is on the side of death, not of life, in man's always precarious evolutionary struggle. It is a disease that first undermines the agricultural economy and then saps the life of the whole society. It is relentlessly undermining the structure of modern civilization, for it strikes at our basic and irreplaceable capital.

In the last analysis, our relation to the earth is an ethical problem. Primitive peoples, like our own American Indians, understood this. They had a deep religious reverence for the earth and its fruits and a profound, if not "scientific," insight into the need for harmony between man and nature. Modern man has broken off his contact with nature, hiding with a sense of false but uneasy security behind his mechanistic and illusory contraptions for comfort. He indolently imagines that, having with incredible and irreverent nonchalance destroyed the earth and its fruits, he can grow his food in window-box chemicals or manufacture it from coal-tar. We need to replace this Ersatz psychology with a real feeling for nature. We do not have to become sun-worshipers, but we do need to hitch our scientific and social intelligence to a humble recognition that man is only a part of nature. Man does not "conquer" nature. He has the privilege of understanding and working with nature. If he fails, nature conquers him.

THE MECHANIZATION OF AGRICULTURE

The industrial revolution descended on man before he was civilized enough to cope with its impact either on the human race or on the earth. With the immense growth of population in the past century and a half, the need for food and timber has outpaced our skill in dealing with nature, just as industrialism has outpaced our skill in organizing production for the welfare of all people.

The machine age induced an enormous population pressure to exploit the fertility of the soil and to use the accumulated wealth of forests and grass-lands recklessly. Agriculture was mechanized in more than its machinery; it was mechanized in its ideas. Transportation and the development of world markets put a cash premium on one-crop farming and on exporting soil fertility in the form of food, thus putting a double strain on the fertility stored by nature. Artificial fertilizers became a shot in the arm in lieu of the more laborious and complicated methods of keeping up fertility by restoring organic matter through the use of manure, composts, and crop residues.

Farms, in short, became food factories where fertility was sweated out of the soil. The cities, to be sure, gained enormously in a cheap and abundant supply of food. But mechanized agriculture has brought much evil, along with the good, to the agricultural populations that have adopted it. Crop surpluses, agricultural depression, farm bankruptcy, and the ominous growth of the new serfdom, farm tenantry, are aspects of this evil. But the basic evil is the immense destruction of soil capital by soil depletion and erosion.

The domestication and improvement of food plants by prehistoric man is no doubt the most important scientific achievement of the race. By creating agriculture, these discoveries created civilization. But agriculture may now undermine and destroy civilization unless it undergoes a cultural revolution

as profound and far-reaching as the domestication of food plants. This new revolution may be defined in terms of a grand strategy of using plants to stabilize soil and water, so that the modern world may establish a true harmony of man and earth. This grand strategy we might define as geoculture, in the sense that it will consciously develop all types of land culture—farm crops, grass-lands, forests, and waters—into a broadly conceived, farflung, integrated design. This design must be superimposed on whole continents, in a way to satisfy both the economic needs of men and the physico-biological needs of the soil-water-plant-animal complex.

THE SOIL CRISIS CAN BE SOLVED

The modern world now has both the technology and the social resources to achieve this revolutionary strategy. The very nature of the soil-water-plant complex as an interrelated system of forces in dynamic equilibrium dictates not only the technology of this new land-use strategy or geoculture, but also in large measure the social, administrative, cooperative, and fiscal mechanisms required to put it into effect. Most men merely shrug their shoulders over the dismal tale of land destruction and its ominous portent for the future. This attitude, however, is not necessarily a mark of indifference. It arises from the cosmic scope of the problem and the seeming impotence of man in the face of it. Our impotence, however, does not arise from the nature of the problem itself, gigantic as it is. Experience in various countries shows that men can develop the arts of farm, forest, and grass-land management to a high state of perfection. Our feeling of impotence comes from the dominance of traditionalism and inertia in the arts of government and in the methods of organizing science for human use.

The world soil crisis is not insoluble. Its solution, however, requires a thorough technological revolution in agriculture

and land use. That, in turn, requires a revolution in the minds of agricultural technicians, scientists, educators, administrators, and legislators, as well as of land users. It requires developing and deploying a common fund of tactical and strategic concepts in the war against land destruction. It requires social invention and a clean break with timid scientific and social traditionalism.

The basic concept of the new land-use strategy is that reestablishing an equilibrium in the soil-water-plant complex cannot be done piecemeal. The haphazard introduction of piecemeal scientific "improvements" in agriculture is not enough. The unity of nature demands a unified strategy of man's treatment of nature. Water *can* be tamed and turned to use. Soil *can* be stabilized. Plant and animal life *can* be developed to be our allies and servants. But we must create means adequate to these ends. *There must be a common set of strategic principles at the core of agricultural policy.* There must be a streamlined and simplified administration as integrated, complete, and efficient as an army corps, for, like war, soil destruction will not trifle with intellectual incompetence, administrative disorder, scientific timidity, or improvised, halfhearted expedients. And there must be, above all, minds capable of dealing with the biological unity of nature, whether on the individual acre, the farm, the watershed, or the continent. For the dynamics of the soil-water-plant complex are inseparable and indivisible, and in reestablishing the balance of nature we have to deal with whole rivers and their drainage basins, and in fact, with whole continents.

The soil crisis is a man-made crisis. It exists in dimensions of whole continents and social organisms. It is clear, therefore, that only concerted national and international action can halt the deterioration of the habitable earth and its threat to civilization. This concerted action must enlist the agricultural population of the world in a great cooperative, creative enterprise. Such an enterprise has implications that reach far be-

yond economic considerations. The pathological disorders of modern civilization are rooted in general apathy and indolence toward organizing men for cooperative action to use science and technology in a war on ignorance, disease, and poverty. The war has bred an enormous disillusion and cynicism as to man's nature and destiny. After the long orgy of madness and slaughter, mankind needs an antidote to cynicism and a means to spiritual redemption. The new conquest of nature, the new scientific frontier, offers a grand design for the reevocation of man's creative powers and for the recapture of large ethical purpose.

The grandeur of design that must go into the reordering of our lands and rivers will be repellent to those who confuse democracy with incompetence and freedom with a planless and drifting society. Man has perfected incomparable tools of science in all realms of life, but social invention in using those tools for human welfare is disorganized and laggard. Only by social design and engineering on a grand scale can man reap the fruits of his scientific genius. Social design and engineering will in itself become a science—the science of sciences—through which democracy will come into its own because only thus can men become free. This book, tentative and incomplete, deals with the broad aspects of the social design and engineering that must be applied to one of the greatest of mankind's problems: reconciling civilization with nature.

3

The Democratic Revolution in Soil Conservation

In the ferment of social and economic reorganization that began in the United States as a result of the Great Depression, it is doubtful if in the perspective of history any of the reforms then launched will be more basic and enduring than the great program of soil conservation. Popular apprehension over the wastage of natural resources, especially soils, forests, grass-lands, and waters, had been mounting for a good many years. But except for the enormous expansion of the National Forests under President Theodore Roosevelt, no far-reaching measures had been taken to cope with the obvious and appalling wastage of our national patrimony until, in 1933, the Soil Conservation Service began its dramatic attack on soil erosion, the short-lived lumber code under the National Recovery Act pointed the way to forest reconstruction, the TVA began to teach the world how to tame and harness a great river, and, in 1934, the Taylor Grazing Act began to abate the ruinous overgrazing of the great western grass-lands of the public domain.

The reasons for this lethargy toward the wastage of natural resources were numerous. In the first third of the twentieth century, America was just fully emerging from the pioneer period when the stored riches of nature were mistaken for a perpetual and limitless abundance. More important, although the pioneers had tamed a continent, they had not tamed them-

selves. Exploitation was the accepted economic philosophy, buttressed by the unalloyed doctrine of laissez-faire individualism. Social and economic order, according to our most respectable traditions, automatically arose from the energetic pursuit of individual self-interest, no matter how narrow, selfish, or shortsighted. With its limitless energy and seemingly limitless resources, America had grown great on this philosophy, which was so ingrained that the restive American temperament, nurtured on continental conquest, resisted the encroachment of social action.

Although our natural resources, under the impact of unregulated exploitation, had suffered perhaps more than any other segment of our economy from our faith in social automatism, it was impossible to make any great headway against the dominant current of social belief until very recent years. That was all the more true because even among the experts and administrators who understood the critical situation of our natural resources, the great majority shared the dominant political philosophy of laissez-faire drift, tinctured with the naive faith that linear progress, goaded by whiffs of propaganda, would, somehow or other, bring competent technical management to bear on one of the most intricate and pressing problems facing mankind—the husbandry of the earth.

A whole generation before, in the administration of Theodore Roosevelt, the National Conservation Congress had proposed an amazingly far-reaching series of measures to set our national estate in order; but World War I, quickly followed by the triumphant return of "normalcy" and the philosophy of social drift, laid these proposals on the shelf. Marked advance had been made, to be sure, in the science and art of forest and range management in the National Forests; but these were public lands, where the landlord could do as he wished. Fortunately for the American people, the landlord was, collectively speaking, the disciples and apostles of Theodore Roosevelt and Gifford Pinchot, who valiantly and against

great odds held the National Forest enterprise through more than two decades against the repeated massed assaults of exploitative interests. But elsewhere, in the vast area of our private farm and forest-lands, as well as on the farflung grass-lands of the unreserved and unprotected public domain, the problem of conservation was virtually untouched. Our land resources were melting away at a geometric rate of progression and our great rivers were roaring seaward with ever-increasing loads of flood-water and silt.

Even if political reaction and public indifference had not blocked the way to an effective conservation program, the arts of government administration and of social engineering in the United States had not yet reached a stage of maturity where they could cope with such an immense, sprawling job as that of bringing order into the mounting disorder of our land and water resources. We required not only a new philosophy of social action but new concepts of administration and engineering. If science was to be applied to land use and water control in a way commensurable with the magnitude of the task, it would have to operate with ideas at once precise and large. It would have to meet not only the economic needs of the land owner but the ecological needs of nature. It could no longer think in bits and segments, for nature is a unity, not an assemblage of fragments; and scientific land management had to begin to think in terms of the integrated treatment not only of entire farms, but of entire rivers, valleys, and drainage basins as interlocking natural systems. Quite obviously, our traditional way of applying science to agriculture through the so-called "extension" method was incapable of dealing with such an integrated concept of natural-resource management, for agricultural extension was essentially a publicity method devoted to the piecemeal diffusion of new scientific discoveries about agriculture rather than the development and application of integrated principles of land management. It had become clear that "scientific agriculture" was a contradiction in terms unless

it could weave together in one pattern all the scientific methods that were required to stabilize soils, vegetation, and water. For without a completely articulated management, the land and its resources become wasting assets, whose dissipation ruins first the owner, then the community, and ultimately, if unchecked, the nation as a whole.

AN INTELLECTUAL REVOLUTION IN LAND MANAGEMENT

Thus, despite the existence of an elaborate and costly structure of agricultural research, education, and extension, the breakdown of our land and water resources was going on unchecked and with increasing momentum when, in 1933, the New Deal opened the way to renewed social energy and social invention in many fields of human action. It was particularly receptive to bold attacks on the conservation problem.

In all that burst of energy and invention, nothing was destined to be more spectacularly successful or more fundamentally important in the destiny of mankind than the Soil Erosion Service (later renamed the Soil Conservation Service), created in 1933 by Dr. Hugh Hammond Bennett under the friendly wing of the Interior Department. For this was no mere specialized bureau devoted to the relentless and single-handed pursuit of a fragment of science. On the contrary, it marked a fundamental historical revolution in the basic nature of agriculture itself, in the methods of applying science to human welfare, and in the art of social organization and engineering. In its phenomenal growth, in the extraordinary popular support it has enlisted, and in the world-wide interest it has aroused, the great American experiment in soil and water conservation can now be definitely ranked as the most important revolution in agriculture since primitive man domesticated the food plants. For it has shown, on a gigantic scale, how to farm the land without destroying it, how ordinary men can cooperatively make use of science on a grand scale, and how

civilized man can solve the paradox of a growing population and a dwindling land supply.

BOLD IMPROVISATION

In its first break with the timid traditions of science, the Soil Conservation Service boldly embarked on a series of huge demonstrations of erosion control in all parts of the United States before the methods of erosion control had been worked out and tested by precise scientific research. This was a courageous (and, as it turned out, a successful) improvisation. The ominous advance of erosion demanded action rather than cloistered experiment, just as war may force a nation to fight without perfect armaments. Various devices and methods had, to be sure, been experimented with to check erosion; but they were at best fragmentary and inadequate. Hitherto, no one had ever attempted to fit together into a coherent whole all the devices and methods that were necessary to control surface water, to stabilize the soil, and to develop naturalistic principles of land management. Still less had anyone tried to work out all the many variable patterns for erosion control demanded by the enormous diversity of soil types, topography, climate, vegetation, and agrarian economy of a vast continental land area, and to fit these patterns to whole watersheds. Such was the enormous province the soil conservation demonstration areas set forth to conquer.

In a surprisingly short time, with the voluntary cooperation of thousands of farmers and with substantial help from the Civilian Conservation Corps, the Soil Conservation Service had set up several hundred large demonstration areas, ranging in size from a few thousand to several hundred thousand acres. These demonstrations were so distributed as to include virtually every major type of soil, climate, and agricultural economy in the United States. Thus, besides being available to great masses of people for study, they are truly encyclopedic and ex-

haustive in their pioneering task. They are not merely demonstrations, but laboratories. For in the process of bringing large land areas under conservation control, the technicians had to improvise their methods as they developed their operations, and were constantly testing, modifying, and discarding techniques suggested or dictated by local conditions. This process is still going on; but nevertheless it is fair to say that the demonstration areas have virtually perfected most of the basic methods of erosion control, with an enormous range of variability and flexibility suitable to a very wide range of natural conditions. Never in history had science been marshaled on so vast a scale against such a complicated set of problems in such a thoroughly integrated mode of attack. It was the total lightning war of science.

A NEW TYPE OF DEMOCRATIC SOCIAL ACTION

When the demonstration projects were well advanced, it became apparent that, despite the importance of their pioneering task, they were only the advance wave of the main assault on the ominous inroads of erosion throughout the United States. For demonstration alone was not sufficient to activate land owners to make a thorough application of the new techniques on the enormous aggregate of lands that had been injured by erosion. It was clear, too, that the government could not meet the costs of a general widespread application of erosion control as it had met the bulk of the costs of the demonstration projects. It was therefore suggested[1] that a model State law be drafted for the creation of self-governing soil conservation districts to cooperate with the government in the widespread application of conservation practices in such a way

1 *Report to the Secretary of the Interior on the Soil Erosion Service and on a Permanent Coordinated Program of Soil Erosion Control,* by the Committee on Soil Erosion, Ward Shepard, Chairman, Charles F. Shaw, and W. W. Johnston, Dec. 18, 1934 (MS).

that the land owners would assume the bulk of the cost while the government would provide mainly technical guidance.

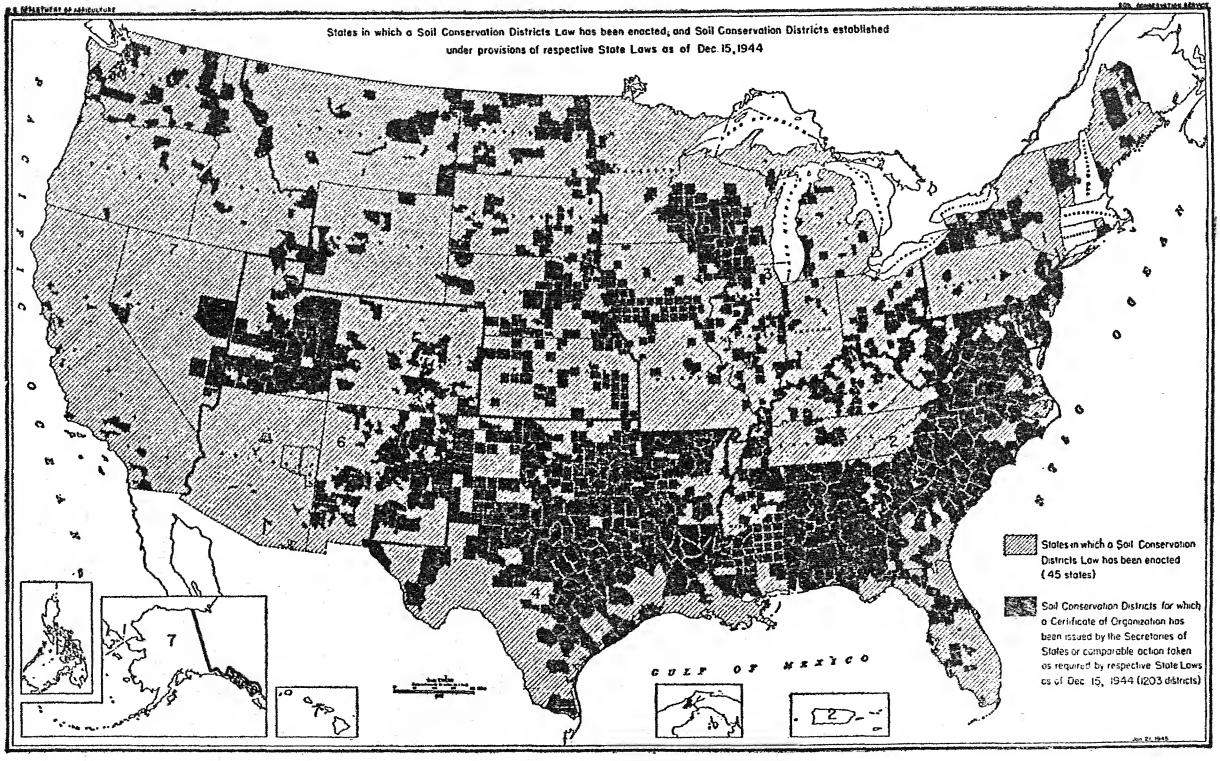
Underlying this recommendation was a strong sense of skepticism that the mere demonstration of the complicated technology of conservation farming was sufficient to enable the farmer to transplant that technology to his own farm, even if the demonstration gave him a desire to do so. It was as unrealistic to expect him to achieve such a *tour de force* as it would be to expect people to master the piano by listening to the great virtuosos. Rather, the demonstration areas were to be regarded as successful pioneering proofs that the job of erosion control could be mastered—proofs that were at least as necessary for legislators, administrators, publicists, educators, and technicians as for farmers. What the farmer individually needed was concrete, specific guidance on his own land with its own special problems; and what farmers collectively needed was a cooperative mechanism of action, so that land deterioration in a given watershed or region could be collectively and spiritedly attacked. It was these two needs that the proposed standard State soil conservation district act was designed to meet. Its essence was to be responsible democratic action combined with expert technical guidance. Its purpose was to provide a cooperative mechanism through which a truly integrated scientific management could be brought to bear on the land.

In 1935, the Department of Agriculture, to which the Soil Conservation Service had been transferred, embodied these proposals in a Standard Soil Conservation District Act, which was drafted in consultation with agricultural agencies of a number of States. President Roosevelt sent this proposed standard act to the Governors of all the States with the recommendation that the act be passed by the State legislatures as the basis of Federal-State cooperation for soil conservation. Somewhat later, Federal cooperation in this field with any State was made contingent on the adoption of the act. The standard act,

with some modifications required by State constitutions and, in a few States, with other modifications that somewhat weakened its effectiveness, has been adopted by forty-five of the forty-eight States. Already a total of 1285 soil conservation districts have been created embracing a gross area of more than 700 million acres of land (over a third of our whole land area) and a population of over 3 million farmers.

AN ALLIANCE OF FARMERS AND EXPERTS

The soil conservation districts are thus a political and social phenomenon of the first magnitude. They represent, in fact, a new type of government instrumentality—a democratic mechanism in which millions of people are voluntarily cooperating with experts in the full-scale and whole-hearted application of science to the art of living from and with the earth. The new integrated techniques of soil and water conservation, implemented through the democratic and revolutionary movement of the soil conservation districts, give modern man the tools to conquer soil erosion, to harness the rivers, to stabilize the soil and its fertility, and thus to lay the foundation for agricultural stability and adequate world nutrition. In no other realm of human life has science been so fully organized for human welfare and on such a vast scale. The soil conservation districts completely refute the widespread and naively snobbish belief among the educated classes that the masses of men are dull and hidebound and incapable of making use of the highest technological advances. They point indeed to a complete revision of our traditional concepts of organizing science for human use, and give an unmistakable clue to the paradox of the dazzling advance of science and the dismal lag of social progress. It is not the people who drive a horse and buggy, but the leaders of science, education, and government who collectively show an amazing lack of social inventiveness and courage, and allow the wondrous fruits of science to rot before they are ripe.


States in which a Soil Conservation Districts Law has been enacted, and Soil Conservation Districts established under provisions of respective State Laws as of Dec 15, 1944
States in which a Soil Conservation Districts Law has been enacted (45 states)
Soil Conservation Districts for which a Certificate of Organization has been issued by the Secretaries of States or comparable action taken as required by respective State Laws as of Dec 15, 1944 (1203 districts)
GULF OF MEXICO

It is inconceivable that the soil conservation district movement could have spread so swiftly over such an enormous extent of land embracing millions of people if it had not accurately responded to a felt need and to a genuinely popular sentiment as to how that need could be cooperatively met. The experience to date, in fact, clearly indicates that rural people are eagerly responsive to an institutional framework which permits and encourages effective cooperative and social action. Politically, this demonstration is of basic importance, far beyond the conservation movement. The tendency in government and industry has been strongly in the direction of specialized, bureaucratic hierarchies whose function it is to do the things they think the people need, instead of making it possible for the people to organize to do them. Underlying this trend is skepticism as to the ability of the people to organize themselves for effective cooperative action. Yet, in the soil conservation districts, millions of people have banded themselves together to undertake, with technical aid, the complicated technology of erosion control and good land management. The soil conservation districts are a resounding answer to our own technocratic managerial revolutionists and to all the foreign brands of totalitarianism. They are a complete victory for the democratic control of modern technology.

ARCHETYPE OF ECONOMIC DEMOCRACY

The soil conservation districts are engaged in one of the greatest technological and cultural revolutions in history—namely, the basic reorganization of agriculture under the carefully articulated and integrated principles of soil conservation. The clue to this unusually vital social mechanism is the combination of formal and responsible popular organization with a competent technical-managerial service. It is possible, in fact, that this mechanism is the archetype of the coming economic democracy, being at once the answer to the disorganized

drift of laissez-faire, and to the lethal coercion of authoritarianism.

"Regimentation" has become a very loose-jointed word, and some excited individualists have applied it to the soil conservation districts, presumably in the naive belief that any kind of organized social action is a wicked restraint of inborn liberties. Social action or opinion of any kind whatsoever has a measure of restraint or constraint on that mythical being, the pure individual, of whom the only specimen we have a record of is Robinson Crusoe. But cooperative social action of the creative kind has an even larger measure of release and enlargement of the individual.

In the case of the soil conservation districts, cooperative action was dictated by the very nature of the problem to be dealt with. There was no remotely adequate mechanism to bring the fruits of modern agricultural science to guide the farmer in his complicated task. There was no administrative organization and no finished scientific technology to control the movement of soil and water throughout whole watersheds or to prevent the mismanagement of one farmer from ruining the land of his neighbors or from contributing its share to the ruin of the whole watershed. Obviously, the individual farmer had everything to gain and nothing to lose in making his capital, the land, proof against disintegration by the elements; and he would be the first to scoff at the idea of "regimentation" being involved in his joining with his neighbors and with technical advisers to root out the cancer of soil destruction. Still less are the people as a whole likely to apprehend any regimentation in the intelligent and energetic cooperative efforts of farmers and experts to halt the destruction of the national patrimony which, in its essence, belongs to all the people and not merely to the holders of the title-deeds.

The soil conservation districts exemplify so many of the principles of scientific and social action required for guarding the world's soils and food supply that their nature and sig-

nificance are of basic interest to all people everywhere. They prove, first of all, that a competent land husbandry capable of safeguarding the general public interest in this basic resource cannot be achieved by our traditional modes of agriculture and our traditional modes of scientific propaganda, but only by a thoroughgoing, organized alliance between land owners and experts. Secondly, they show that the complete interrelatedness of the natural forces involved in soil and water conservation dictates a unitary and global attack and dooms a fragmentary and piecemeal approach to failure. Third, they exemplify strikingly successful forms of democratic action. And, fourth, they show that far-reaching government intervention in land use is feasible and acceptable provided it is based on democratic processes. They thus point the way to the democratic reorganization of world agriculture on scientific lines as technologically effective as mass production in modern industry, and far more socially effective in the widespread distribution of benefits.

DISTRICTS ARE SELF-ORGANIZED AND SELF-GOVERNING

The soil conservation districts, under the standard soil conservation district laws, can be set up only with the approval of the State soil conservation committee and only after an affirmative majority vote of the land users (owners and tenants) within the proposed districts. Yet once they are set up, they are legal bodies-politic with definitely prescribed rights and responsibilities. Each district has an elected board of supervisors with very broad powers. Its principal powers are to plan conservation programs for the district; to cooperate financially and otherwise with land owners to carry out such programs; to lease or buy land; to take over and operate Federal and State soil conservation projects; to cooperate with Federal, State, county, educational, and private agencies in conservation works; and to draft enforcible land-use regulations, which,

however, become effective only after an affirmative majority vote of land users. In addition to the board of supervisors, there is provision also for an elected board of appeals, in case the district shall have adopted mandatory land-use regulations, to adjudicate grievances of individual land owners against the enforcement of regulations that may be unduly onerous. From an adverse decision of this board, an appeal may be taken to a court of competent jurisdiction. This appeal procedure, first to an elected board and second to the courts, protects the individual land owner against any unfair, arbitrary, or harsh measures of control; and it also protects the district itself against the familiar charge of regimentation in measures of collective security which seem to impinge on the "rights" of the individual.

The standard act also establishes a State soil conservation committee, in whose membership are usually included the State commissioner of agriculture, the director of agricultural extension, the chief of the agricultural experiment station, and a representative of the Federal government. The State committee has its own technical staff, and promotes the organization of districts, defines their boundaries, holds elections, coordinates the various district programs, and assists the districts with technical advice and in some cases with financial and other aid.

THE ROLE OF THE TECHNICAL EXPERT

In practice, most of the governmental cooperation with these districts comes from the Soil Conservation Service, though State extension services, agricultural colleges, and other agencies give assistance in many States. The most essential element of this cooperation is that the Soil Conservation Service provides a technical advisory service to assist the board of supervisors and through them the farmers, in planning and executing soil conservation programs.

Another essential element in this cooperation is that governmental agencies give a certain degree of subsidy in kind, such as fencing materials, seed, and the use of heavy machinery in the initial phases of reorganizing the farm layout for conservation farming. This type of subsidy should not be confused with the cash benefit type of subsidy used by the Agricultural Adjustment Administration for certain limited and fragmentary types of conservation. It is a purely temporary subsidy to help farmers in the relatively heavy capital investment involved in farm reorganization, whereas the Agricultural Adjustment Administration benefit payment was a cash payment made annually to induce the farmer to adopt and continue certain limited conservation practices. The one is a temporary grant-in-aid to assist in farm conversion; the other is a true subsidy made partly in the interest of conservation and partly of increasing the farmer's income.[2]

It is not to be expected that the board of supervisors will be expert technicians in all the many applied sciences that enter into soil conservation. Their task is essentially the guidance and promotion of the movement among the people of the district. They rely on guidance from the technicians in making the preliminary general plans for the whole district, but it is the supervisors who pass on the adequacy and practicability of those plans. The technicians make the detailed conservation plans for individual farms in cooperation with the owners or tenants, but it is the supervisors who organize public opin-

[2] The agricultural subsidy program in recent years has been based on an indirect reduction of surplus crops, like wheat and cotton, by subsidizing farmers to plant soil-conserving crops like grass and alfalfa. This shift from direct cash payments for surplus crop reduction was necessitated by the Supreme Court's invalidation of the original Agricultural Adjustment Act. While this subsidized promotion of diversified agriculture has achieved much good, both in stabilizing agriculture and promoting soil fertility, it is a fragmentary approach as contrasted with the completely articulated ecological-engineering program of the Soil Conservation Service and is in no sense a substitute for that program.

ion to the point of accepting the help of the technicians. And the supervisors, not the technicians, have the function of proposing land-use regulations and of enforcing them if they are adopted by the voters of the district. Thus, in essence, the soil conservation district is a democratic, voluntary, self-governing entity of local government that may go so far as to subject itself to legally enforcible land-use controls required for community welfare. The technicians are there to advise, to guide, and if need be to prod; but it is the community itself that has the final responsibility.

WHY EXPERT ADVISERS NECESSARY

If we observe what has to be done in a given soil conservation district to reach the goal of complete conservation, we can better understand why the combination of the land user and the expert adviser is so effective. Some districts are organized to cover watersheds, some follow county lines; but in either event complete watershed or drainage-basin control is the goal of the conservation program. The watershed is the logical unit of conservation strategy, since the watershed sets the framework for the movement of water and besides has a geological, vegetal, and frequently an economic and social unity.

For the watershed as a whole it is necessary for experts, using precision methods, to determine from the nature of the soils, slopes, vegetation, rainfall, and other factors, what lands can safely be plowed, what steeper lands must be used for pasture with dense soil-holding sod, and what steepest or poorest lands must be used for forest, the best of all soil- and water-holders, and with the capacity to thrive on poor land.

These decisions can be made only through expert investigation and judgment, based on detailed experience in the erodibility of different soils under different conditions. With these decisions made, each farm must be reorganized to conform

with these basic demands of nature. This is, of course, the responsibility of the land owner himself, but the complexity of the job requires expert guidance. This guidance is achieved through the detailed farm management plan, which is worked out jointly by the farmer and the technicians. Conservation techniques are so elastic that the farmer has a wide range of freedom in choosing the crops he will raise and the general type of farming he will follow; in fact, conservation farming enormously enriches his range of choice.

The function of the expert is to help fit these choices into a coherent whole based on the fundamental principles of soil and water stabilization. Consequently, the management plan jointly worked out describes in detail the engineering, cultural, and cropping practices for each part of the farm over a period of years in a way to enable the farmer to reach both his economic and his conservation goals. *The farm management plan is the key to and the tool for the scientific reorganization of world agriculture. It is the only means of meeting the farmer's need for a completely coherent scientific agriculture. It is the only means to protect the general public interest in natural resources. It is the modern streamlined substitute for the fragmentary propagandistic methods of "extension" education. It is the irreducible minimum in reorganizing world agriculture to meet world nutrition needs. It is the tool for combating surpluses and stabilizing agriculture. It is the textbook and the university of scientific land use.* The world deterioration of soil resources cannot be checked until governments provide expert services, in organized land management districts, on a scale of intensity to bring all land under scientific management by the method of the complete management plan. The cost of such a service will be wiped out, many times over, by the immense capital gain in stabilizing world soils, in the immense increase in soil productivity, and in conserving our water resources and harnessing our rivers.

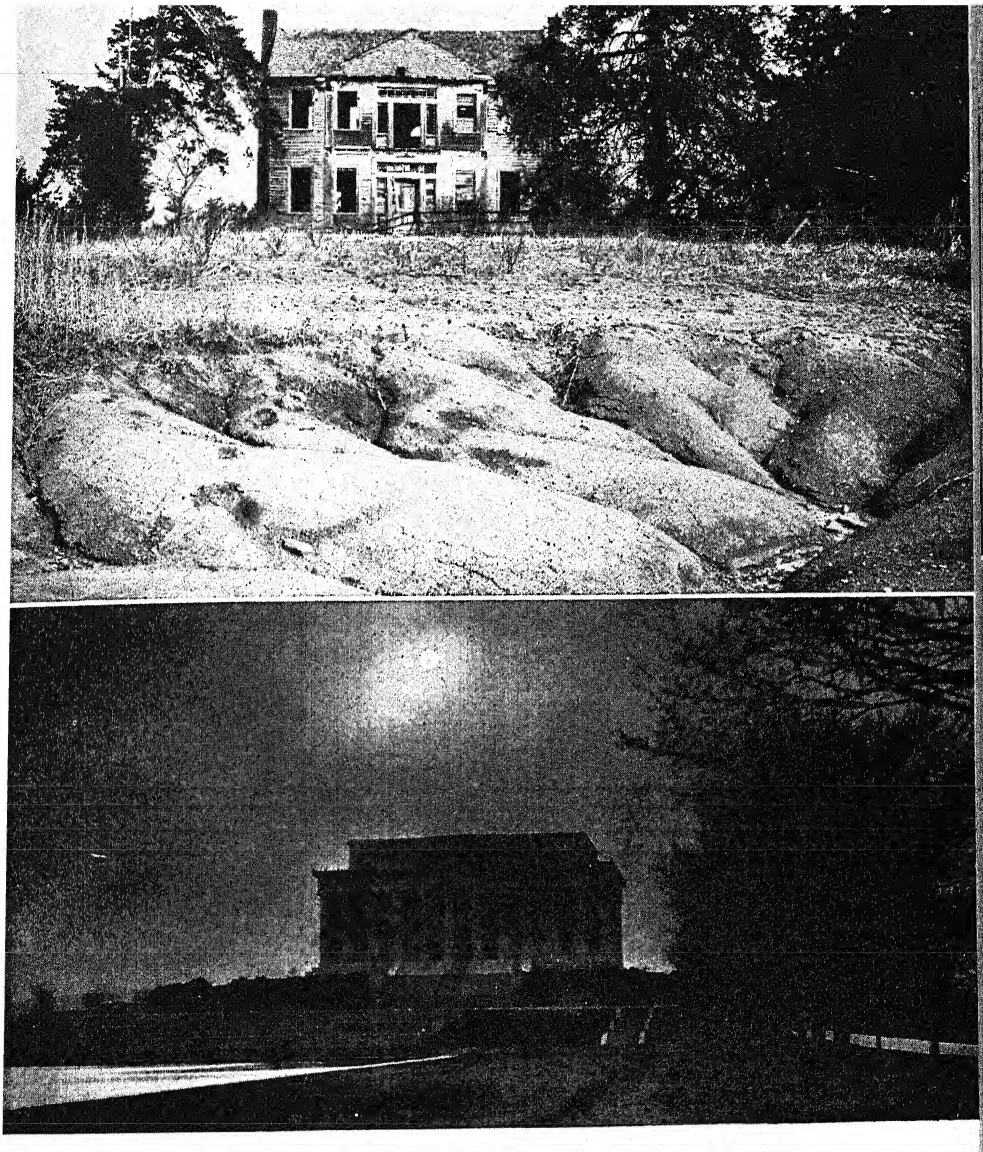


PLATE 3. Our expensive civilization is built on a crumbling foundation.
Upper. Advancing erosion spells poverty and depopulation.
Lower. The Lincoln Memorial has a visit from The Dustbowl, March 1935.

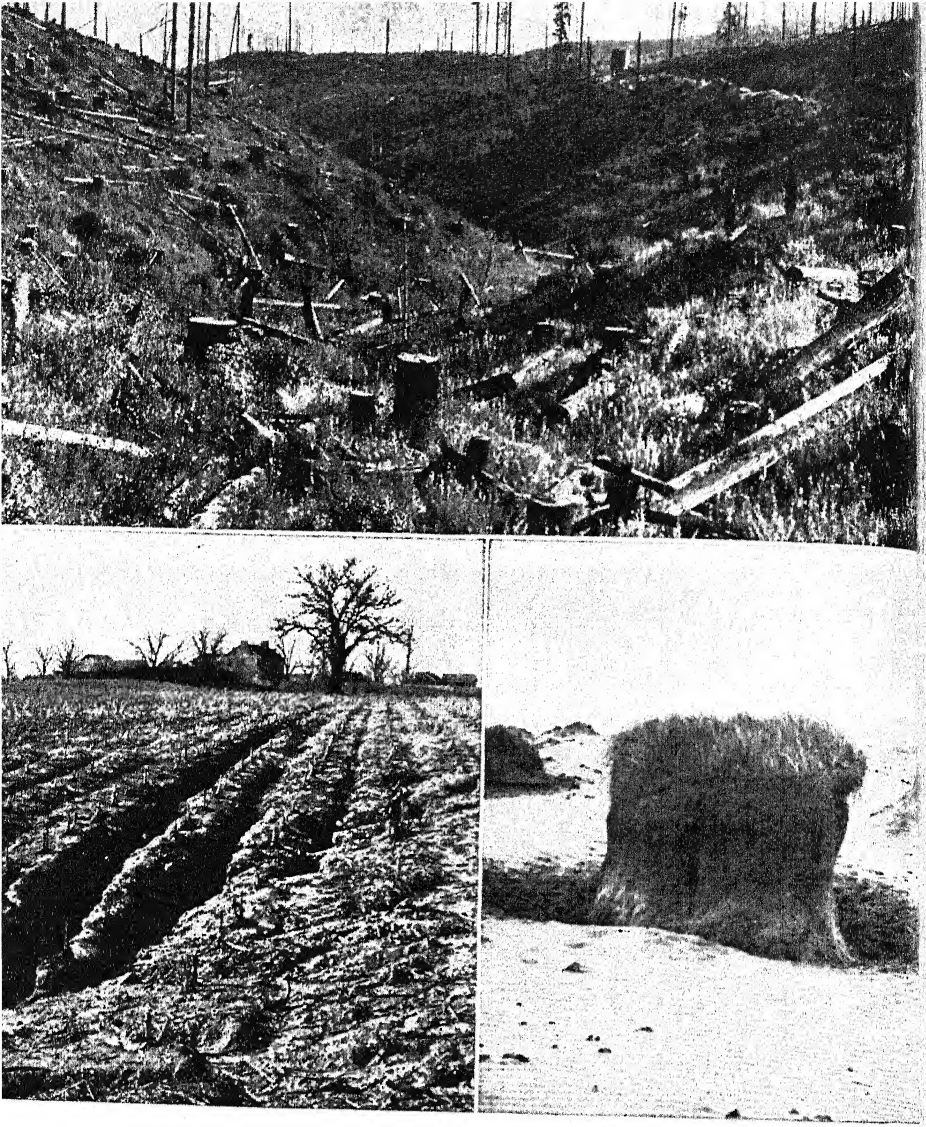


PLATE 4. All types of land mismanagement contribute to our flood and erosion problem.
Upper. Deforestation.
Lower left. Up-and-downhill plowing.
Lower right. Overgrazing and denudation of grasslands.

THE COMPLEXITY OF CONSERVATION TECHNOLOGY

Even the complete treatment of all the individual farms in a given watershed does not meet all the needs of the watershed as a whole. There are such over-all problems as safe disposal of surplus runoff, locating flood-control dams and reservoirs, stream-bank protection, roadside erosion control, drainage, submarginal land purchase, and wildlife management, all of which require expert solution. Wildlife is an outstanding case of this need. The relation of animals to each other and to their environment constitutes one of the most subtle and least-known aspects of the ecology of conservation. Wildlife management and restoration must be functionally fused with total conservation in such a way that wild animals can perform their role in the economy of nature and man.

The complex and intricate measures required for erosion control, water conservation, and fertility rebuilding on arable land most vividly illustrate why progress in conservation is overwhelmingly a problem of aiding the farmer to work out a truly complete and integrated farm management plan rather than a problem that can be solved by propaganda methods for the diffusion of scientific knowledge.

The vast extent of soil erosion and soil exhaustion on our arable lands has been induced primarily by one-crop farming and up-and-down-hill plowing, which together exhaust the stored humus and permit the washing away of the topsoil in which nature stored it. Conservation farming, as the first step, gets all plowing on the level or "contour," the furrows winding gracefully round the slopes on the level instead of cutting straight across them and thus running up and down hill. These level furrows absorb and impound water in the soil, whereas down-hill furrows act as ditches for swift runoff that peels and carries away the topsoil layer by layer, ultimately down to subsoil or bedrock.

Up-and-down-hill plowing has been used since the plow was first invented, and is probably responsible for more man-made erosion and soil destruction on arable lands than all other causes combined. The contour furrow consequently is one of the most important inventions of the human race. It is as simple, as elemental, and as overwhelmingly important as fire or the wheel. No one knows who first invented it, or where, or when. But it never became effective until the Soil Conservation Service adopted it as the basic element of soil conservation. When it became integrated into a complete system of land management, it received the enormous accretion of power that the wheel received when Watt invented the steam engine. The contour furrow is man's greatest defense against future hunger.

Superimposed over the contour furrows that are the basis of soil conservation is a system of strip-cropping, each crop occupying a band or strip about 50 to 100 feet wide planted also on the contour and winding like broad ribbons round the sloping fields. Strips of dense, water-holding crops like grass alternate with strips of row crops like corn, which are poor waterholders, in order to act as buffers against down-hill movement of water and soil. Each of these strips is in fact a field, for the gracefully winding strip replaces the familiar square field, and the strips are elaborately rotated from year to year from dense to row crops, from soil-depleting to soil-building crops, and moreover are kept constantly in vegetative cover by a year-round succession of crops. On steeper lands where contour plowing and strip-cropping are inadequate to hold the water and soil, broad terraces are built. By carefully engineered, diked, and grassed waterways, all surplus water running off the fields in heavy rainstorms is safely carried into stream channels without damaging the soil. Pasture-lands are improved, planted, and tended to maintain a dense vigorous sod, and woodlands are rebuilt by planting, thinning, selective cutting, and other cultural operations.

This generalized description of the basic elements of inte-

grated conservation gives little idea of the enormous diversity and flexibility of the practices that have been worked out to fit the highly diversified soils, climate, and agricultural economy of our very diversified land. Thus, in the semi-arid plains, the main problem is to husband the very scant moisture and to prevent erosion by wind as well as by water. On grazing lands, natural revegetation of native grasses and other valuable plants in order to rebuild a dense plant cover on depleted soils is obtained chiefly by careful control of the number and distribution of livestock, though many supplementary measures such as water-spreading dikes and spaced contour furrows to catch water on slopes are used. Orchards and vineyards are also planted and cultivated on the contour. Finally, one of the gigantic engineering aspects of erosion control is to halt the further progress of the millions of gullies that are dissecting and devouring our soils and clogging our great rivers with billions of tons of silt. Gullies represent an advanced stage of devegetation and erosion, where an excessive runoff of silt-laden water scours out channels in the natural waterways. Once a gully starts to cut into the soil, it gnaws constantly upstream and sends out side branches until whole valleys are dissected and made useless for agriculture. To heal gullies requires the building of check dams or the planting of soil-holding plants like the kudzu vine, in order to form silt traps and gradually fill the gully back to the level of the flood plain.

THE BROAD STRATEGY OF EROSION CONTROL

However varied the techniques of erosion control under different natural conditions, they all have two common objectives. One objective is to slow down the movement of water into stream channels and consequently reduce its capacity to transport soil. The other main objective is to rebuild and maintain the lost fertility of the soil.

The new methods to control water falling on the land sur-

face is a momentous achievement for civilization. Billions of tons of rain-water, pounding and cutting the soil of barren fields, denuded ranges, and devastated forests, are not only destroying our soils, but are lost to any effective human use by rolling downstream in gigantic floods. Conservation agriculture captures this water and tames it to human use by sending it down into the soil. Traditional agriculture, with its immense wastage of water, has the same practical effect as a sharp reduction in rainfall. Even in humid regions, like western Europe and eastern United States, droughts and semi-droughts are frequent enough to seriously affect average crop yields and carry-overs. Conservation agriculture puts the water into the soil where it can be used for plant growth and thus neutralize all but the severest droughts. Equally important, from the broad economic standpoint, is the fact that it feeds the surplus water not needed for plant growth into underground channels where it slowly percolates into the streams and rivers as clear water, devoid of silt, and thus equalizes and stabilizes the flow of streams, creeks, and rivers. Conservation agriculture is thus the basic principle of flood control and river development; elaborate systems of dams and levees are doomed to defeat unless they are based on the complete control of water and soil throughout the whole drainage basin.

The second momentous achievement of conservation agriculture is rebuilding and stabilizing soil fertility. Having pinned the soil down in place, it is in a position to make worthwhile efforts to recharge it with fertility. Soil fertility is not a condition, but a process. It is a ceaseless activity in which dead organic matter is disintegrated by minute organisms and combines with disintegrating mineral elements to produce plant-food. In some of the older countries, like western Europe and China, agricultural methods are more or less adequately maintaining the humus supply. In the newer lands colonized by Europeans, however, an ominous factor in the future food supply is in the drastic reduction of the stored humus of the soil.

This reduction is in part due to sheer soil exploitation, but equally or more to the actual destruction of topsoil by erosion. In this age of seeking short-cuts to salvation, we have vainly imagined that soil fertility can be maintained by the use of chemical fertilizers. This is a dangerous and misleading exaggeration. Chemicals can at best be a supplement to natural fertility, for only the continuous process of humus formation can give the texture and tilth required for vigorous plant growth and prevent the soil from becoming compacted and dead. By the use of elaborate rotations of soil-building crops, improved pastures, winter cover-crops, and green-manure crops in a completely stabilized topsoil, conservation agriculture has fully developed naturalistic methods of keeping soil fertility and has thus reduced chemical fertilization to its proper supplementary role.

DIVERSIFICATION AND INCREASED YIELDS

Obviously so complete a technological change in farming involves also great economic changes, both for the individual farmer and for the entire agricultural and nutritional economy. There is first the element of cost involved in the shift from the old agriculture to the new. This is primarily a capital investment in such forms as relocating fences to permit contour cultivation, terracing, filling gullies, constructing safe waterways, planting trees, and providing seed and fertilizer for a complex system of rotation and succession. The need for credit to assist farmers in making this conversion is treated elsewhere. Offsetting these costs and far more significant are the economic benefits from crop diversification and the greatly increased yields of the new agriculture.

The technologies required for soil and water conservation force the abandonment of one-crop farming. Strip-cropping, adequate rotations, yearlong plant cover, and the emphasis on grasses and legumes as soil-builders shifts the farm economy

from one-crop, cash-crop farming to a balanced livestock economy in order to consume the increased forage crops. Thus instead of selling his soil fertility in cash crops, the farmer feeds a large share of his crops to livestock, which return fertility to the soil in the form of manure. This great diversification gives the farmer a double security. It protects him against the periodic crop failure characteristic of one-crop farming. It protects him against price-slumps due to overproduction of the staple crops. And it protects him above all against the destruction of his basic capital by soil exhaustion.

The great crop diversification required by conservation farming is one of the main keys to the solution of the nutrition problem. Regions given over to commercial one-crop farming are usually characterized by inadequate diets, especially among the rural population. While modern transportation tends to offset such local shortages among urban populations, there is no question that food will be much more varied, abundant, fresh, and cheap in regions where diversified farming is developed to the full. Diversified farming directed to conserving the soil, stabilizing agriculture, and adequately feeding regional populations need not be confused with the totalitarian doctrine of autarchy. Fascist autarchy in agriculture is not a measure of soil conservation or of improved nutrition. It is a preparation for total war, as when Italy attempted to greatly expand wheat production at the expense both of her soil and of a diversified food supply.

Equally important as diversification, both to the agricultural economy and to adequate nutrition, are the greatly increased yields of conservation farming and the permanent maintenance of these yields at a high level. The men who pioneered the new farming were themselves amazed at the rapidity with which it restored fertility and increased crop yields. Thus, in the Southern Piedmont—one of the worst regions of soil erosion in the world—it has been found feasible to restore lands that ten years ago had been classified as destroyed beyond

further use. A recent survey of 2000 farms in the South that have been under conservation management only a few years shows an average increase of $856 a year in individual farm income. This great increase of production, due partly to conserving water in the soil and partly to recreating the fertility of the soil, is not surprising when contrasted with the great decline in production due to erosion. Where the topsoil has been stripped off down to the subsoil, crops decline over three-fourths in yield. Looking at the country as a whole, even with our fairly extensive agricultural methods that are likely to persist for many years, it now seems conservative to say that conservation farming will increase crop yields by at least 50 percent. Disregarding the threat of so-called "surplus" crop production, which is dealt with elsewhere, the significance to world nutrition of such an increase in food production and even more its maintenance at a high level is quite obvious.

TOTAL CONSERVATION NOT A LAYMAN'S ART

An important lesson emerging from the accumulated experience of the soil conservation districts is that the art of scientific land management requires an over-all design as precise and as integrated as great engineering works or as mass production in industry. Consequently, it is a fallacy to suppose that mere educational propaganda can qualify hundreds of millions of farmers and peasants throughout the world to undertake the task of land reconstruction. The soil conservation districts have demonstrated the feasibility of an operating alliance between the organized land users and the land engineering experts.

In the management of natural grass-lands and forests, the need for expert guidance is even stronger than in the case of farm-lands. From prehistoric times the folklore of agriculture has been mastered by successive generations of men without benefit of technicians and has always been more or less com-

petent to feed the race, though it has rarely been competent to deal with soil destruction. But there has never been and never can be a comparable folklore for the management of native grass-lands and forests. The reason is an ecological one. Farm crops are monocultures, each crop a simple plant association, subject to definite and easily ascertainable laws of reproduction, growth, culture, and harvesting. Natural grass-lands and forests are highly complex plant associations, containing usually on any given acre a large variety of plant species, each with its own individual habits of growth, nutrition, and reproduction. Range and forest management requires a detailed knowledge of these plants and their habits both as individuals and in their complex interrelations, in order to utilize their growth without impairing their vitality as an organic complex. The mismanagement of forests and grass-lands impairs and finally destroys not only the soil but the plant association itself.

Thus, the very nature of the conservation enterprise requires a drastic reorganization of the methods of applying science to land management. The complex art of maintaining a perpetual equilibrium between soil, water, and plants—what may, in other words, be called ecological engineering—is not a layman's art. If ecological engineering is to be applied to the land and water resources of the world, then we must create the necessary corps of ecological engineers, advisers, planners, and strategists who will provide the essential expert services to land owners organized for effective cooperation. We do not expect laymen to be their own physicians, lawyers, architects, engineers, or electricians. The shift of world agriculture from the exploitative folklore stage to a fully integrated scientific management is comparable to the shift of industry from handicrafts to mass machine production. Expert management is the key to both, and this management must henceforth be assumed to be a part of the "cost" of production in agriculture as it is in industry.

LAND MANAGEMENT IS MORE THAN EDUCATION

Education has played and will continue to play a very important part in the promotion of conservation and other agricultural sciences. But education of the "extension" type, which is the traditional method of applying the agricultural sciences to the land, is no longer capable of meeting the needs either of the land owners for scientific management or of the general public for the conservation of our natural resources and for the maintenance of an adequate food supply. *The democratically organized, officially responsible land management district with a corps of advisory experts is the basic mechanism for the scientific reorganization of land husbandry and for the control of agricultural production.* It is analogous to a group health organization, in which a number of people organize cooperatively and contract with a group of medical specialists for their expert, coordinated service in combating disease and maintaining health.

There is a fundamental difference of methodology between the organized land management district, with an advisory service devoted to integral land management, and the traditional attack on scientific agriculture known as "extension" education. With the rapid growth of the agricultural sciences during the past century, agricultural educators and scientists took steps to acquaint farmers with the advances in agricultural science. This undertaking has relied mainly on educational methods, such as demonstrations of improved methods, personal advice on specific problems, publications, meetings, and lectures.

Our own Agricultural Extension Service has been typical of this approach. It was organized as a cooperative enterprise between the Federal Department of Agriculture, the State agricultural colleges, and the counties. The county agent system was set up as the local educational device, with various special-

ists operating from the State colleges to assist the county agents. In carrying the knowledge of improved agricultural practices to farmers, the basic method of the Extension Service is the so-called "project" method. A project is an undertaking to promote the introduction of some one improved farming method, such as the use of lime to counteract soil acidity, better care of poultry, or the introduction of better sires for cattle breeding. The selection of projects depends in considerable part on the personal interest of the individual extension agent.

The extension method has revealed a number of basic weaknesses which dictate its thorough overhauling and its integration into the land management district movement. The project method has put a premium on overspecialization and the dissection of farm management into fragments. It has overwhelmingly dealt with single, isolated scientific practices rather than with the whole series of correlated and articulated practices which, combined into a unified whole, constitute scientific farm management. Moreover, it has tended to concentrate on the better educated and more prosperous farmers who are quick to take advantage of improved methods, to the neglect of the small, less educated subsistence farmers where the incidence of poverty, malnutrition, and soil destruction constitutes the gravest of our rural maladjustments. Moreover, the extension approach has been in general highly individualized and not primarily focused on organizing the farmers for effective cooperative action on the outstanding basic agricultural problems. Consequently, the adoption of scientific methods of agriculture has been exceedingly spotty and fragmentary.

It is a fair criticism of the extension method, despite its genuine influence in spreading new discoveries, that it is a highly dispersive, fragmented method of promoting science in a field in which the crying need is for integration. It is, in fact, an unscientific method of applying science, since it lacks the orderliness of science itself and the clearly defined goals without which agricultural reorganization is impossible. An indirect

proof of the inadequacy of the extension method to grapple with the basic problems of agriculture is the fact that the government was forced to create the Farm Security Administration to reorganize subsistence agriculture, the Soil Conservation Service to cope scientifically with the universal disaster of soil erosion, and the Agricultural Adjustment Administration to deal with the economic maladjustments of agriculture. Although the extension services, under the influence of these new agricultural services, have broadened their grasp of agricultural problems, they are tending, in fact, to become service branches of the newer agencies, and in the process of further coordination, will probably be absorbed into a more comprehensive and unified agricultural service.

EXTENSION AND MANAGEMENT MUST BE MERGED

The imperative needs of world soil conservation and world nutrition demand a far more coherent, organized, and effective method of applying scientific management to the world's agricultural soils than is afforded by the fragmentary and dispersive methods of extension. If science is the ordering of knowledge, then the methods by which the fruits of science are made available for daily human use are also amenable to scientific ordering. It is notorious that the bulk of the world's soils are deteriorating and that the bulk of the world's agricultural population are poverty-stricken and undernourished. On the other hand, the agricultural sciences, including the new science and art of soil conservation, could revolutionize world agriculture, world nutrition, and the economic and social status of the world agricultural population if these sciences were effectively applied. If modern men are to enjoy the benefits of science, they cannot depend on the slow processes of "cultural diffusion," but must develop coherent cooperative social instrumentalities to capture science and apply it wholeheartedly to the affairs of daily life. Science need no longer be a scarcity

product, monopolized by a few and doled out in homeopathic doses. It can be socialized and democratized.

In the case of agriculture, it is essential that our basic concepts of agricultural education and extension be thoroughly overhauled and modernized. *Specifically, agricultural extension, instead of being an independent and competing agency, should be merged into the land management district as its educational arm.* It would promote the universal organization of land management districts, the universal adoption of complete farm management plans, and the testing and adoption of new scientific methods. In such a role, extension could contribute far more to the advancement of agriculture than it is now able to do, and would play its part in unifying and coordinating the numerous agricultural services whose present pattern of confusion, conflict, overlapping, and competition must be replaced by a unified land management strategy.

LAND MANAGEMENT DISTRICT AS CENTER OF AGRICULTURAL ADMINISTRATION

The concrete pattern of action in conservation is the stabilization and reconstruction of the water-soil-vegetation complex, which, as previously noted, argues strongly for the watershed as the unit of land management—the large watershed for the over-all strategy of flood prevention, power development, and natural resource development; the smaller watershed for the tactical and detailed phases of land operation and upstream engineering. Later we shall discuss means of integrating large and small watershed development. Here it suffices to point out that the small primary land management district has already become a widely used unit in the United States. It is the primary unit of administration in the National Forests, the public domain Grazing Districts, and the Soil Conservation Districts, which collectively embrace over 1 billion acres of land, or over half of our total land area. Ranging from 200,000 to a

million acres, this primary unit is of a size to permit effective operation of a small staff in direct contact with the people. It is essential that such districts be organized over our entire land area and become the centers for the local coordination, fusion, and simplification of the overcomplicated land use programs and the supernumerary agencies concerned with the technological and economic problems of agriculture. There will unquestionably be increasing social intervention in agricultural production throughout the world, for the benefit both of the farmers and of the population as a whole. The land management district forms a cohesive and responsible focal democratic unit with which government can deal effectively in a wide range of agricultural problems.

NON-MATERIAL MOTIVES FOR CONSERVATION

Cooperative organization, technical guidance, and thoroughly integrated workmanship are the key to the remarkable success of the soil conservation districts. Yet neither the technological nor the economic advantages of conservation farming wholly account for the eager responsiveness of the rural people to the new agriculture. The modern world has cultivated the fallacy that the profit motive is the main, if not the only motive, of human activity, and has thereby dangerously narrowed the enterprises and goals of civilization. This squalid doctrine, combined with its cognate fiction, aggressive and self-centered individualism, has produced the universal spiritual malnutrition that is the clue to much of the unrest of the twentieth century. By a curious paradox, the philosophy of individualism, so far from making strong individuals, has weakened them by destroying the civic virtues that are nourished by cooperative social action for great purposes.

The soil conservation districts have evoked a tremendous social energy on a challenging creative task of the greatest significance to human life. Beyond mere technology, one senses

in the soil conservation districts the great intellectual and emotional stimulation that are urging the people on to the mastery of exciting discoveries in the realm of social workmanship. Perhaps the most subtle of the motives behind the new agriculture is its striking esthetic effects. Here is landscape engineering on a grand scale that is transforming vast regions into veritable gardens. Rigorously responsive to the exacting demands of nature and harmoniously fitted into her great cycles, conservation farming is functional art of a high order on a stupendous scale. The soil conservation districts give men the opportunity to work together for common ideals. Men everywhere are hungry for great social enterprises that embody idealistic and imaginative goals. A civilization that neglects great cooperative social enterprises (and our modern materialistic civilization with its narrow pecuniary standards has dangerously neglected them) loses the dynamic power of the deeper energies of human nature and ultimately is infected with the apathy and dry rot that destroy nations.

CONSERVATION WITHOUT SUBSIDY

This psychological motive is not introduced for sentimental reasons, but because of its immense practical importance in answering the question, How are we going to get the gigantic conservation job done? Must we buy and pay for every stroke of work men are to do to keep the earth habitable? This question is not academic: much of the agricultural reform program of recent years has been based on the theory that people must be subsidized to do what is to their own obvious interest. In the soil conservation districts, scores of thousands of men are at work energetically and enthusiastically creating the new agriculture, with little help beyond technical guidance. They give a glimpse of the possibilities of a social order in which men evoke and multiply their powers by joining with others in great idealistic tasks for the common good.

4

The Organization of Forest Management

IN CONTRAST with the extraordinary efflorescence of the soil conservation movement, the history of forest conservation in the United States has been paradoxical. It was the pioneer of the entire conservation movement in America, having received its initial momentum in the 1870's from the suggestion of Carl Schurz, Secretary of the Interior, that the unreserved public timber-lands be set aside as National Forests. Schurz's suggestion bore magnificent fruit in our great system of public forests. But in the domain of private forests, which constitute the great bulk of our forested land and of our potential forest production, America has suffered an appalling tragedy of waste and destruction. As a result we are faced not merely with a drastic and long-drawn-out shortage of timber, but with a gigantic and costly job of forest rehabilitation. It has taken us a century to destroy our forests; even with the will, it is doubtful if we can restore them in a century.

Not that we have not made progress in many directions, notably in forest-fire protection, in forestry research, and here and there in private forest management for continuous production. But looking at our forest area as a whole, despite these advances, it remains true that the National Forests constitute our single great achievement in applying scientific management to our forests, and that the steady deterioration and de-

struction of our forest wealth is one of the greatest challenges and tests of creative statesmanship this nation faces. Just as we are entering an era of unprecedented power and industrial development, we find ourselves incredibly weak in timber, which has, besides all its familiar uses, unlimited potentialities for new chemical uses.

The National Forests constitute our oldest and most solidly established conservation enterprise. Their outstanding success is all the more surprising because they were initiated in the 1890's, in the heyday of rugged individualism, when the public ownership of natural resources was looked upon as heterodox. Only the powerful personalities of Grover Cleveland, Theodore Roosevelt, and Gifford Pinchot made this great triumph of social common sense possible. Had it not been for the visionary practicality of these "prophets of the utterly absurd," much of this vast and magnificent empire of forests would long since have been laid waste by fire and the ax in the march of industrial "progress."

These great public properties, now embracing about 175 million acres of forest-land, mostly in the western mountains on the headwaters of some of our greatest rivers, were created to assure a permanent supply of timber and forage and to protect our water supply. They have been skilfully managed for these great aims with business sense, technical competence, and a comprehensive philosophy of their broad social objectives. They are an impressive demonstration of the art of managing our natural resources for permanent production and of the immense social practicality and wisdom of such management. Perennially productive, they mantle the great mountain ranges with their protective cover, give economic stability to the industries and communities dependent on their annual yield of timber and forage, perpetually safeguard at least a fraction of our timber supply, protect the sources of some of our greatest rivers, and—not least important—give to

millions of our people the esthetic and recreational enjoyment of beautifully kept forests and streams.

PRIVATE FORESTS LAG IN MANAGEMENT

When we turn to the great area of forest-lands in private ownership, roughly four times the timbered area of the National Forests, the picture is very different. All but a fraction of these forest-lands, embracing some 340 million acres of large commercial holdings and of farm woodlands, with generally much more favorable timber-growing capacity than the National Forests, have been, and continue to be, destructively exploited without any reference either to the biology or to the economics of continuous forest management. There are numerous examples of good forest management in industrial and farm forests, and a number of forest industrial associations are successfully promoting a more widespread interest in forestry among their members. Nevertheless, the most optimistic reliable estimate would not class more than 8 percent of our private forests as being under technical forestry management.[1]

Undoubtedly there have been and there are now many difficulties and obstacles in the way of adopting good management in our private forests. Nevertheless, the main obstacle has been and remains a psychological one. In the post-Civil War era of industrial expansion, the forest industries grew up, naturally enough, to liquidate the stored wealth of our forests, and they have never got far beyond that goal. There has never existed in any country, least of all in pioneering America, a folklore of forestry as there has been, for ages, a folklore of agriculture. The forest is the highest and most complicated of plant asso-

1 Clarence F. Korstian, *Forestry on Private Lands in the United States,* Bulletin 8, Duke University, School of Forestry, 1944. This study was made under the auspices of the National Lumber Manufacturers Association.

ciations; its scientific management must be based on the complex interrelations of such a plant association. Consequently, permanent forest management requires expert technicians. No country in the world has good forest management except as its forests are staffed and managed by such technicians.

The tragic deforestation of America has resulted from failure to recognize this basic need. On the one hand, the forest industries have been dominated by the philosophy of liquidation. On the other hand, public leadership has failed to organize practical ways and means to assure that technical forest management is adopted and applied. Instead of coming to grips directly with the basic application of forest management on the ground—that is, with a specific program of conversion from destructive clear-cutting to selective cutting and sustained yield management—the emphasis in legislative policy has been to supply ameliorating aids like forest-fire protection and forest tax reform in the fallacious belief that, with such aids, forest owners and industries themselves, without direct government intervention and leadership, would undertake to work out this intricate task of conversion. The naive belief underlying this policy is that forest owners would understand, recognize, and act upon far-reaching and long-range public interests involved in perpetuating our forests for the benefit of all the people, and would voluntarily work out a system of forest management to protect those interests. Quite obviously this is a gross exaggeration of the responsibility of industry. It is the function of government to recognize and protect the public interest, immediate and long-range, and to reconcile industrial programs and policies with that public interest. It is time to recognize that the weak policy of appeasement and wishful thinking offers no real solution of our forest problem, and that the only solution lies in government and forest owners collaborating in a vast nation-wide undertaking

to apply intensive technical management to our entire forest area.

THE TEMPTATION OF FOREST LIQUIDATION

The very nature of the forest itself aided and abetted the philosophy of liquidation. For the forest is both capital and income, mixed together. Each growing tree is a factory (capital) that produces ultimate income by putting on a layer of wood by each year's growth. In order to keep a forest permanently productive, it is necessary to keep enough trees growing at all times to utilize the total growth capacity of the forest soil and to harvest only the surplus of mature trees as income. This tree capital is known as the forest growing stock and is the key to our whole forest problem. If the tree capital is impaired, the income of growth falls off proportionally.

Unfortunately, the tree capital, as soon as it is big enough to use, can be prematurely harvested as fictitious income by overcutting or clean cutting. Forest owners, with a short-range and frequently false view of their own interests, are under constant temptation to expropriate this forest capital. This practice has led to widespread and ruinous forest deterioration and destruction and more clearly than anything else illustrates one of the basic theses of this study, that land deterioration represents capital expropriation and its restoration capital investment rather than upkeep. In the case of the forest, this capital expropriation goes far beyond mere quantitative overcutting of timber. For it destroys the complex equilibrium of the forest vegetation and soil, permits the invasion of shrubs and weed trees, dries out the soil, promotes forest fires that carry the cycle of destruction further, permits rapid soil deterioration and erosion, and destroys the ecological unity of the forest as a vigorous natural entity. This degenerative process finally converts the forest into an economic and biological wasteland.

ECONOMICS OF FORESTRY

If there has been a general lack of understanding among forest owners of the biology of forestry, there has been an equal lack of understanding of the basic economics of continuous forest management. Good economic management requires the cutting of the larger trees and leaving the intermediate and smaller trees for further growth, which occurs with redoubled rapidity once their chief competitors are removed. Timber cutting can be practically organized so as to move across a whole forest in a period of from three to ten years (depending on climate, species, and growth rate), cutting only the mature trees, then returning to the point of beginning and repeating this process ad infinitum. In addition, small timber, like fuelwood, pulpwood, and poles, can be procured by thinning and weeding the younger stands, leaving the better trees properly spaced for rapid growth. In the forests of central and western Europe, this system has been organized to a high degree of perfection. These forests have been managed from one to several centuries by this so-called principle of sustained yield management. Consequently, they are in a state of perpetual equilibrium, biological and economic, since they always contain a fixed amount of mature and growing timber, and each year a new age-class reaches maturity just as each year a new age-class of young men reaches the age of military service. Moreover, the European pulp and paper and wood chemical industries obtain their wood supply from repeated thinnings designed to remove inferior or crowded trees, thus releasing the better ones.

The method of sustained yield management thus, in effect, neutralizes the great time span required for the maturing of an individual tree, and makes timber as much an annual crop as cotton or potatoes, by the simple device of harvesting each year only the trees that have become mature that year. Mathe-

matically, the annual harvest equals the total previous year's growth on all trees, large and small; but as the orchardist does not harvest green fruit, so the forester does not harvest immature trees, except in thinning. The science of exact forest measurement has been developed to the point where this measurement can be made with negligible error; in fact, it is possible to predict the growth and harvest decades ahead. The well-managed forest is like a perennial spring with an outflow always equal to its intake.

THE INERTIA OF FOREST DESTRUCTION

The principle of "selective" cutting—of taking the mature trees and leaving the younger ones to grow up—is more profitable, from the private owner's standpoint, than the almost universally prevalent "clean cutting" which, by sweeping away the entire forest, has destroyed much of our forest growing stock or capital; and from the public and social standpoint, no other system has any justification. For the immediate advantage of the owner, it is ordinarily much cheaper, in terms of cost per thousand board feet of lumber, to log and manufacture large trees than small ones, and the resulting lumber is a much higher grade and brings a much better price. Our forests, except in high latitudes and altitudes, are very fast growing; and the residual stands left by selective cutting, speeding up their growth by release from competition, can be logged again every few years.

Yet scores of millions of deforested, abandoned acres of forest-land are a tragic monument to the industrial and social folly of ignoring this elementary lesson of good business, private and public. It is largely by sheer inertia and tradition that we go on slaughtering our capital growing stock of young vigorous trees by the method of clean cutting without even realizing that the cutting of the young trees is done at a positive loss which must be recouped from the profits made on the

larger trees. This system, besides destroying the vitality and productivity of our forests, floods the market with the low-grade unprofitable lumber cut from small trees. These hidden losses have contributed greatly to the recurrent and almost chronic depression of the lumber industry. It is as if the live-stock industry each year sold for slaughter not only the natural increase of its herds, but the breeding stock as well. The intellectual inertia that has gone into the continued devastation of our forests year after year is clearly shown by the fact that on most of our industrial holdings there has never even been a factual analysis of this problem and still less a realistic system of cost-accounting that would reveal these enormous losses of clean cutting.

LIQUIDATION OR MANAGEMENT?

It is not to be inferred that inertia and lack of curiosity about technical forest management are the sole causes of deforestation. The large forest industries have been based on the competitive, speculative acquisition of large timber holdings, many of them bought at high prices and entailing burdensome carrying charges of interest, taxes, and fire protection pending the time they could be logged. When, to the traditional policy of liquidating timber holdings, was added the difficulty of meeting carrying charges on speculative holdings, the forest industries entered into a race of overproduction and price-cutting that have destroyed much of our forest wealth and made these industries and the communities dependent on them highly unstable and evanescent.

These difficulties are not insoluble, but their solution will require a far higher type of imagination and statesmanship than either the government or the forest industries have yet revealed. Cheap forest credit, the adoption of the forest yield or income tax in lieu of the property tax which treats the forest as static property instead of income-yielding capital, and a

large program of public forest acquisition are important parts of the solution. But none of these will guarantee a decent forest management. The *sine qua non* of forest management *is* forest management. In a nutshell, forest management means beginning with selective cutting and working toward sustained yield production; in other words, building up a vigorous growing stock or forest capital and restricting the annual cut to the annual growth. This is a long, difficult, and complex job, requiring the full cooperation of government and forest owners. But nothing less than the installation of forest management will safeguard our already badly damaged forests from virtual annihilation. To depend on anything less would be like depending on the collection of roots, herbs, and berries for our food supply instead of depending on organized, scientific agriculture.

DEFORESTATION FAR ADVANCED

The impact of forest destruction on our total economy goes far beyond the losses it entails on the forest owners, large and small. Most of the forests east of the Great Plains have been repeatedly cut over by methods that make no provision whatsoever, beyond fire protection which in many regions is far from adequate, for the maintenance of a growing stock of young and intermediate timber of high quality and vigor. The practice has been to take the best and leave the worst, and each successive cutting undermines the vigor and quality of the forest. The result is that the bulk of the eastern forests are scrub growth, seriously deficient both in density and in quality of stocking and fit chiefly only for fuelwood and very low-grade lumber, for which there is a limited market. This degenerative process is clearly revealed by the New England hurricane of 1938. Of the vast quantity of timber blown down, mostly white pine, only about 6 percent was grade one logs; the rest were culls or low-grade logs suitable only for box-

boards and low-grade construction lumber. Had these forests been under management, the bulk of the timber would have been high grade.

Deforestation is proceeding apace in most of our last reserves of privately owned virgin timber in the Far West, which rank among the most magnificent forests in the world. But it is in eastern America that the end result can be most clearly seen. In some regions, as in the northern Lake States, great areas were swept completely bare of timber and will remain depopulated wastelands until forests are reestablished. Here civilization itself has been destroyed by wiping out the resource on which alone it could be maintained.

Quantitative statistics concerning these cut-over forests are highly misleading. Expressed in terms of board feet or cubic feet of wood, these statistics make an impressive showing as to a future timber supply. Actually, however, most of our second-growth forests are qualitatively so degenerate that they cannot possibly yield the material for forest industries of remotely the magnitude of those still subsisting on the exploitation of our greatly shrunken and rapidly disappearing virgin forests. They are largely composed of misshapen or defective or worthless trees which impose excessive or prohibitive costs of extraction. In fact, our forests as a whole are, through mismanagement, wasting assets with ever-shrinking economic value. The bottom of our worthwhile timber supply is definitely in sight. The disappearance of our last virgin timber will have profound repercussions on our whole economic structure.

DEFORESTATION AND AGRICULTURAL DEPRESSION

In the nineteenth century, eastern rural America was a hive of woodworking industry. Almost every town and village had one or more woodworking factories, where lumber and furniture and wagons and multitudes of other products were turned

out. The logging, sawmilling, and manufacturing gave farmers remunerative occupation in off seasons of farming, and also furnished them with a brisk local market for their farm products. Here was a natural, normal, healthy decentralization of industry that has almost disappeared. For beginning about the middle of the century, lumbering successively stripped most of the forests of New England, the Lake States, the Central States, and much of the South, to the point where now the great bulk of lumbering is concentrated in the Rocky Mountain and Pacific States. With the severe overexploitation of our eastern forests, an important segment of the rural economy almost disappeared. The process is being repeated in the West.

No one has ever tried to compute the income-loss from deforestation to the rural population of the East, but it is conservative to estimate that it amounted to a third of the total income from products and labor. The destruction of our eastern forests is undoubtedly a large element in the chronic depression and maladjustment that afflict agriculture; there can be no permanent stable adjustment of agriculture until these great resources are again brought into production. The magnitude of this hidden economic loss can best be visualized from the fact that of the total land area east of the Great Plains, about 350 million acres are best suited to permanent timber production, at least until such a time as density of population would warrant the large investment required to make the best of these low-grade lands—at most a small fraction—suitable for farm production. Deforestation has drastically unbalanced our agricultural economy. This economic imbalance may be contrasted with the large part that forest management has played in the rural economy of central Europe, where scientific timber harvesting, reforestation, and forest cultural operations afford the rural population part-time wage work every year in both the public and the private forests.

The impact of forest destruction in the Far West will be

even more severe, because the proportion of farm-land to true forest-land is very much smaller than in the East, and agriculture cannot even passably absorb the shock of deforestation.

GOVERNMENT MUST TAKE LEAD IN FOREST MANAGEMENT

Yet considering the complexity and obscurity of the biological and economic principles of sustained yield management, it was folly to expect forest owners to solve this problem of their own volition. Forest management is probably the most difficult field of conservation. The time span in bringing trees to maturity extends over two or three human generations. All trees to be harvested in the periodic cutting cycle must be carefully selected and marked by an expert in both the biology and economics of forest management. The forest growing stock must be periodically weeded and thinned to favor the best trees. The principle of sustained yield management, that is, the annual or periodic cutting within a given forest of only the amount of wood grown in that period, involves intricate measurements of growth rates and volumes, and requires advance planning of the logging operation not merely for years but for decades ahead. In no other human activity is such long-range planning required. All these arts require the forest expert.

The brilliant attack on soil erosion, through organized soil conservation districts, clearly points to the need of an organized attack on deforestation in which government, at various levels, can combine with forest owners for the cooperative application of good forest management. For a brief period, in its early days, the Forest Service cooperated with private forest owners in making and carrying out technical management plans; but Congress abolished this promising service on the false ground that it was an unjustifiable use of public funds, and thus paved the way for the continuance of deforestation. Recently, Congress has appropriated modest funds for establishing experimental forest conservation districts among farm

woodland owners. And, as previously noted, a small fraction of forest owners have pioneered in getting their forests organized and technically managed for continuous production.

Instead of adopting an aggressive, systematic policy of organizing forest management on an areal basis, government policy has relied principally on a weakly developed "educational" program for the solution of a problem that requires detailed technical analysis and planning of concrete forest operations on the ground. After seventy-five years of forestry propaganda and generalized education and demonstration, it is fair to say that only one substantial general advance has been made in private forest management, namely, the development of Federal-State-private forest-fire control. Though as yet far from complete, this forest protection system is a vitally important achievement, an indispensable foundation on which to erect forest management; but it is no substitute for the positive cultural treatment of the forest, through technical management, to produce a vigorous, high-quality growing stock. Over many years both the government and the forest industries have rationalized to themselves and to the public the fallacy that forest-fire protection was the main solution of our forest problem. Only an increasing intensity of cultural management can make our immense area of forest-land contribute its share to our standard of living and employ the labor and the industrial plant which its vast fertility will support. In no other aspect of our economic life do we so supinely accept progressive degeneration of a basic resource as the foundation of national prosperity.

URGENT NEED FOR FOREST MANAGERIAL SERVICE

The case for the prompt and universal installation of scientific forest management is peculiarly compelling because of the steady deterioration of our forest growing stock or capital. We have a very large aggregate acreage of young, middle-aged, and

mature second-growth timber, in fair to poor condition, which by the cultural operations of selective cutting, combined with weeding and thinning, can be improved in quantity and quality and speeded up in growth to the point at least of giving some alleviation to the coming timber shortage until, two or three generations hence, our forests are fully productive.

To safeguard and improve this young forest generation before it is too late requires statesmanship of magnitude and boldness. The time is short. If the degenerative process continues unchecked and the remaining virgin timber and younger growing stock is liquidated, there will be little forest capital for private enterprise to build on. For the forest industries, in order to feed their machines, must have back of them an immense volume of constantly maturing timber. The continued liquidation of our forest growing stock will thus dump a double dilemma upon the public: an acute shortage of timber and a gigantic and worthless wasteland, the rehabilitation of which would be beyond the capacity and the patience of the richest nation. Here is a challenge to our collective statesmanship as a people—to continue heedlessly and needlessly laying waste the greatest forest heritage that any nation ever possessed, or to summon the daring, energy, cooperative good will, and above all the managerial skill required to put our forests back on their feet in the little time that remains before they are ruined beyond redemption.

The beginning of a solution boils down to setting up without further loss of time, through the cooperation of the Federal and State governments and forest industries and owners, a competent managerial service, organized on an areal or district basis, to go to work on the complex problems involved in the transition from destructive liquidation to sustained yield management. As in any other complex field of social action, the beginning is a thoroughly organized, systematic attack. The problem of organizing forest management is analogous to that of organizing soil conservation. Both problems are character-

ized by the vast local diversity of conditions to be dealt with and by the many complex factors that must be taken in hand simultaneously and woven into an integral pattern of action. The transition from forest destruction to forest management requires blanketing the country progressively with democratically organized forest districts, where responsible self-government and skilled technical staffs are fused together.

It is not to be expected that the forest industries and owners, voluntarily and independently of broad and strong governmental leadership, will provide an adequate forest managerial service, as is shown by the fact that they employ less than 1000 trained foresters, many of whom are not even engaged in forest management, on the aggregate area of over 200 million acres of industrial forests. Besides these industrial holdings, there is also an aggregate of about 140 million acres of farm woodlands, most of which are also being destructively liquidated in the almost complete absence of technical advisory service. Sentimental appeals and propaganda will not save our forests. They can be saved only by skilled technical management on the ground. It is up to the people of the United States to insist that such management be provided.

FOREST CONSERVATION DISTRICTS NEEDED

It has been proposed,[2] as the first step toward introducing competent forest management in our private forests, that the forests in private ownership be organized into forest conservation districts, to be progressively set up over a period of ten to fifteen years on a priority basis of urgency and importance. Where soil conservation districts already exist or are contemplated, they would be broadened into soil and forest conservation districts with broad powers to bring forest-lands under

2 *Outline of a Proposed Organic Act of Congress to Prevent Forest Degeneration and Destruction and to Preserve and Rebuild Forest Resources,* by Ward Shepard, Jan. 27, 1940 (mimeograph).

intensive management as a part of the farm and regional economy. The Federal government, through act of Congress, would offer the States financial and technical assistance in the proposed districts, provided the States would enact forestry laws requiring that forest owners adopt standards of forest management to assure not only forest reproduction and renewal, but above all, through selective or partial cutting, the preservation of an adequate growing stock of timber to make full use of the growth capacity of the forest soils. This would be State regulation of private forests, backed up with Federal assistance; but it would be regulation in which the forest owners would have an important voice, and in practice, as in the soil conservation districts, it is probable that the advantages of voluntary cooperation toward building up the capital assets of the forest owners would induce all but a minority of them to undertake good forestry management without compulsion. The legal and constitutional aspects of forest regulation are discussed in Chapter 5.

It is probable, of course, that some States would refuse to accept Federal assistance on such terms. In that event the Federal government should unquestionably have the statutory authority to intervene directly to prevent deforestation. Besides imperiling the economic and social welfare of the people as a whole, deforestation adds immeasurably to the difficulties of flood control and of utilizing our great rivers for navigation, electric power, and irrigation. Judging from the history of the soil conservation districts, however, it is probable that most of the forested States would voluntarily cooperate in a Federally sponsored, nation-wide attack against deforestation.

The solution here proposed—namely, reasonably uniform State legislation conforming with standards laid down in a Federal statute, with the alternative of direct Federal action where States fail to act—is a feasible and fair solution of the impasse between centralization and States Rights. The problem to be dealt with is national in its importance and has a very

close relation to the Federal responsibility over navigable streams. Consequently, it cannot be left solely to the discretion of the States, most of which have been singularly apathetic toward the evil of deforestation. Yet the mere failure of the States to act in the past is not an argument *per se* for Federal administrative centralization. In this, as in many other fields of human activity, it is feasible to fuse Federal and local action together in a realistic partnership, recognizing joint rights and joint responsibilities. Dynamic Federal leadership in national policies, with decentralized and localized administration kept at a high level of standards, is the workable substitute for Federal overcentralization on the one hand and a narrow and doctrinaire States-Rights do-nothingism on the other.

UNIFIED COOPERATION NECESSARY

The long-drawn-out deterioration of our forests gives a peculiarly urgent cause for organizing the attack on the areal or district basis. For in many regions, the forests must be cooperatively organized and managed as a condition for the transition to sustained yield management, and even in the regions of large individual holdings, as in the South and on the Pacific Coast, there must be a considerable reorganization of ownership and production facilities in order to get the forest industries on a sustained basis. In regions of predominantly farm woodland holdings, the cooperative organization of forest management, marketing, and even of manufacture will be the clue to the attack. Consequently, the first function of the district technical staff is to get a picture of the forest resources and industries for the district as a whole both as they are and as they must be under a sustained yield program in order to begin an intelligent reorganization of timber-harvesting and manufacturing. Another function of the technical staff will be to work out a balanced program of public forests and parks. But most important of all will be direct technical service to forest

owners in the cultural operations of selective cutting, thinning, weeding, planting, and the planning of sustained yield cuttings over a period of years; for it is on the skilled choice of the individual trees to be cut and those to be left that the fate of the forest depends. The larger forest owners could pay for direct technical service or employ their own technicians. For the smaller owners, the service would have to be mostly gratis, for the present at least.

As in the soil conservation districts, the effectiveness of the attack on forest conservation will hinge on the degree to which forest owners and industries will organize and cooperate in the solution of these technical problems. The rebuilding of the depleted forest resources of a given region is no mere technical problem; it is a problem of social, economic, and industrial reorganization. Moreover, if public regulation of forest exploitation is to be invoked in the public interest, it is essential that the forest owners have an important voice and responsibility in formulating and enforcing such regulations. For these reasons it is necessary to have representative forestry boards in the forest conservation districts, and in the soil conservation districts to expand and define the authority and responsibility of the boards of supervisors in the domain of forestry. This definition must be explicit, for the reason that the standard soil conservation district act does not contain adequate measures for the universal introduction of good forest management. This failure is partly due to the unwarranted assumption that any kind of forest cover, even scrub growth, is good enough for erosion control, whereas, in practice, scrub growth steadily deteriorates through fire and overcutting because there is less and less incentive to maintain it. And even if this were not the case, there is no more economic justification for using scrub timber as a soil-holder than there is to use weeds instead of crops on plowland.

While the plan of forest conservation districts involves public regulation of forest cutting practice, nevertheless in its large

PLATE 5. Place of conservation in the food problem.
Upper. Builds fertility—requires diversification.
Lower. Greatly increases yields. In both photos runty corn at left came from eroding soil, at right from conservation farming.

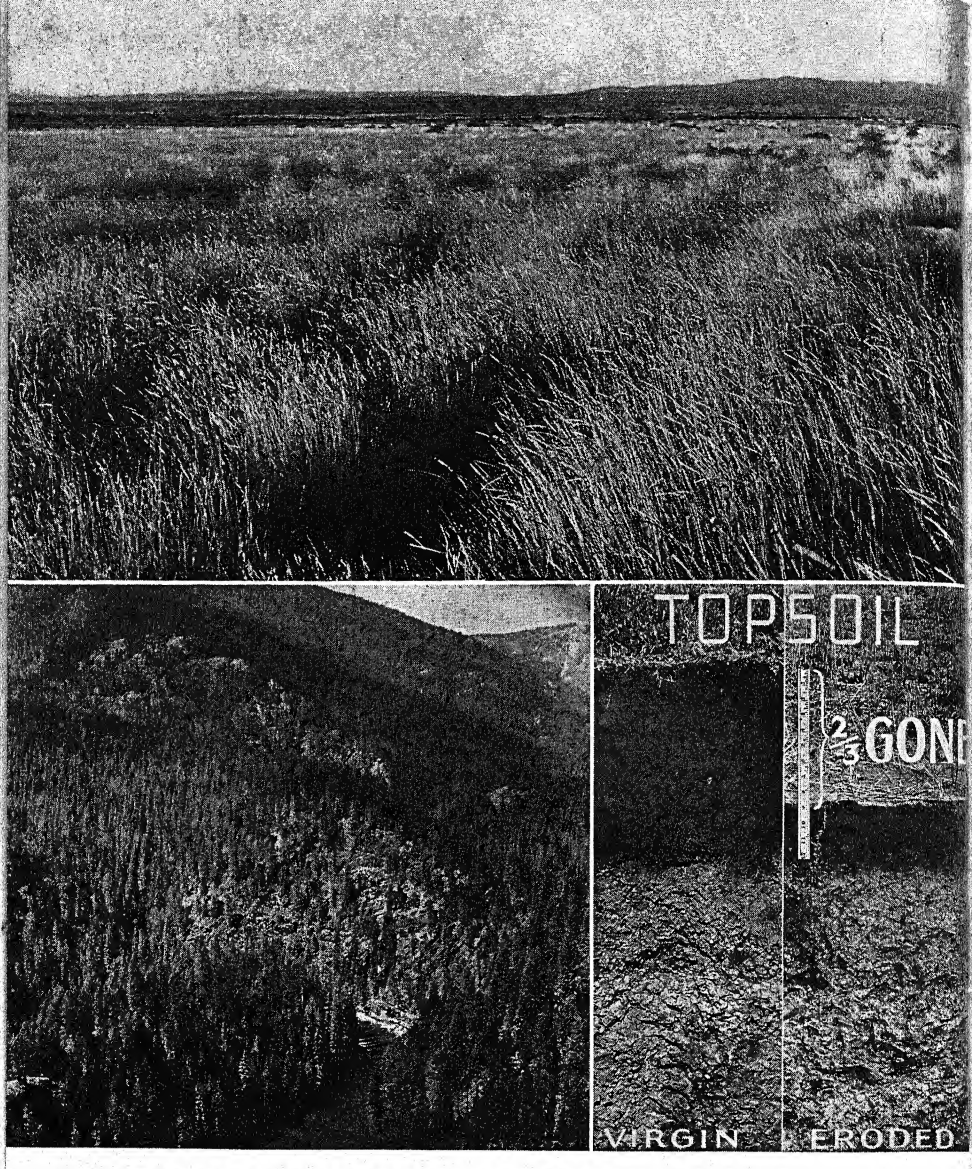


PLATE 6. Plants create the rich topsoil—basic capital of civilization.
Upper. As in well-kept grassland.
Lower left. As in forests.
Lower right. But topsoil is everywhere dwindling from misuse, as in typical soil sample.

outlines it is cooperative rather than coercive. The problems involved in shifting to selective cutting and sustained yield management must be worked out patiently, step by step, over many years, without expecting perfection at any stage. The forest conservation district, with its responsible board of supervisors and with a staff of technicians, forms a cooperating group which can attack the entire range of forestry problems in that district, from cutting practices and reforestation to new logging equipment or the adjustment of manufacturing capacity to timber growth, or the development of new uses of wood and new methods of manufacture. These interrelated problems can be solved only by a continuous process of threshing out, trial and error, survey, research, experiment, education, jointly shared by everyone concerned. It is only by such conscious, systematic, locally organized, day-to-day cooperative work on all the complexities of forest production that the public can have any hope of forest reconstruction and that forest owners themselves can redeem the public responsibility that goes with the trusteeship of natural resources.

ONLY INTENSIVE MANAGEMENT PROFITABLE

Good forest management cannot be invoked overnight. Any overdrastic attempt at public regulation will fail. It will take one to two generations to get our forests into highly productive condition. But the basic principle to be recognized by the private land owner is that the only kind of forestry which will be profitable must, from the very start, be based on relatively high standards of management—namely, the constant cultural improvement and upbuilding of an adequate growing stock. It is folly to persuade the forest owner that a mere wild, weedy, half-stocked forest, produced by occasional seed-trees and fire protection, will be a profitable investment. Over most of the forest regions, such a program will produce only a fraction of a crop, which will not pay interest, taxes, protection, and ad-

ministration. Forest owners cannot make money growing weeds any more than a farmer can. But since our forest policy, or rather its absence, has aided and abetted general forest degeneration, substantial public aid must be given forest owners in rebuilding their growing stock, in the way of increased fire protection, cheap credit, fair taxation, and in some cases outright subsidy for the thinning of young forests. These aids will be highly variable, and only a direct grappling with the intricate problems involved, through the actual operation of the cooperative forest conservation districts here proposed, can give the basis of an equitable system of public aids.

PERMANENCE OF FOREST MANAGERIAL SERVICE

There is one marked difference between soil conservation management and forest management relating to the period during which a fully staffed advisory technical service must function. In the case of soil conservation, there is a good prospect that farmers can maintain all but the most difficult conservation practices once they are thoroughly established and that thereafter the technical advisory staff can be substantially reduced. The art of forest management is more intricate; it involves the selection and marking of the individual trees to be cut, which requires expert judgment of the complex ecological interrelations of the many tree species composing a forest and expert knowledge of the measurement of forest growth. The technical advisory service in the forest districts must therefore be permanent and on a scale to permit this intensive silvicultural practice. However, the total costs involved are trifling compared with the immense economic and social gains of restoring full forest production and the attendant rural economic activity.

Not all forest-land now in private ownership is suited to profitable and effective private management even with a technical advisory service available to the owners. Many forests in

hilly and mountainous country are vitally important for stream protection, but may yield little or no revenue. Many forests are so depleted or devastated that private owners cannot afford to rehabilitate them. There is, in fact, a very large aggregate of such forests that should be purchased by the Federal, State, and local governments to assure their proper management. This question will be considered later in dealing with public land ownership as one major aspect of the conservation problem. But there is still another aspect of the forest problem and of the general land-use problem—namely, public controls to prevent destructive exploitation—that can be most effectively dealt with at this point because forests exhibit most vividly the necessity of such controls and because such controls are necessary to assure the success of the proposed forest conservation district program.

5

Public Controls Over Land Use

As HAS already been seen, the State soil conservation district laws, with a few exceptions, give authority to the districts to adopt, on majority vote of the users, regulations designed to prevent abuses of land that injure others or the public interest. Obviously, practices that dump surplus water or cause soil-washing from one farm to another or gully erosion come within this category. In fact, as all the carefully correlated practices involved in soil conservation need to be applied to large aggregate areas of adjoining farms and to whole watersheds, the potential scope of application of this regulatory power is extensive. However, the individual land owner is protected against arbitrary or unreasonable controls through appeals to the board of appeals and to the courts.

It will be an interesting social experiment indeed to see if land owners will voluntarily regulate themselves under this optional provision. The soil conservation districts are so young (the first was established in 1936) that only a few of them have even reached the stage of considering such regulations. When the issue comes up, as it is bound to come up, it will be an illuminating competition between the growing rural consciousness that soil erosion destroys whole social communities and the ingrained American tradition of individualism and non-interference with private rights. It is becoming apparent that the conservation problem as a whole is well beyond purely individual effort and requires community cooperation, and

from that recognition it is only a step further to requiring general adherence to land-use practices needed to assure community stability.

CONTROL OF FOREST EXPLOITATION

The factors that favor such voluntary self-regulation for soil conservation are the obvious and appalling effects of soil erosion on the economic and social life of the community in which it is rampant and the swift and striking improvement in soil fertility and yields that come from soil conservation practices. Community controls of forest lands have to contend with a different psychology. The evils of complete deforestation are obvious and hideous; but the even more prevalent process of slow and gradual forest deterioration and degeneration, through fire and unskilful cutting, is so insidious that it escapes public attention. The recovery of deteriorated forests through good management is equally slow, requiring one or two generations to show striking results. Whatever may be the prospects of self-regulation in soil conservation, there is no prospect of such voluntary self-regulation in forestry. Yet there is no prospect of saving and restoring our forests without adequate controls against overcutting. Such controls have been found necessary in the old European countries where land ownership has been relatively stable. They are imperative in America where land speculation and rapidly shifting ownership have been a constant temptation to skin farm-lands of their fertility and in the case of forest land to "cut out and get out." Even were land ownership stable and enduring, the long-range social viewpoint would still be essential to prevent shortsighted individual owners from stripping their timberland for a present profit. The individual's lifetime is too short to deal with an enterprise that spans generations; forestry is always likely, in one way or another, to be a mixture of public

and private enterprise, of individual initiative somewhat constrained by long-range social needs.

The need for controls to prevent forest degeneration and deforestation is amply supported by European experience. Every European country where forests are properly managed has these controls in one form or another. In the Scandinavian countries, especially Sweden, a thoroughly democratic system has been worked out. In Sweden the adoption and enforcement of regulations governing forest management and the promotion of good forestry by education are in the hands of provincial forestry boards, which are independent of the State forest service. Each board contains a representative of the national government, the provincial government, and the forest owners. The secretary of the board is a forester who is provided with a staff of technicians and rangers. The work of the provincial boards may be further decentralized through local parish boards. Forest owners may appeal from decisions of the board to the provincial or Federal government. The expenses of the boards are met partly by a severance tax on cut timber and partly by Federal and provincial grants.

AN EXPERIMENT IN FOREST CONTROL

America has had one great experiment in such regulation. In 1933, under the National Recovery Act and at the instigation of President Roosevelt, the lumbermen and foresters worked out codes of forestry practice for the thirteen distinctive forest regions of the United States, and embodied them in the lumber code. Joint forestry boards, representing industry, agriculture, and public agencies, were set up and made responsible for enforcing these rules, through court action if necessary. Rapid progress was being made to secure their widespread adoption when the Supreme Court invalidated the National Recovery Act and thereby incidentally put an end to a most promising democratic experiment in co-

operative but enforceable measures to end destructive liquidation of our forest resources. The experiment was illuminating in revealing the willingness of the forest industries to join wholeheartedly in an enterprise of cooperative controls founded on democratic participation.

Building on this experience, a basically similar pattern of controls has been worked out.[1] The essentials of the plan are that the States will enact effective forest regulatory laws as a condition of Federal cooperation in rehabilitating our forests, or if the States fail to act within a reasonable time the Federal government will use direct Federal controls where necessary to protect the watersheds of navigable streams or to regulate interstate commerce in forest products. Such State laws, to justify Federal cooperation, would have to meet certain standards of selective cutting to assure the perpetuation of an adequate forest growing stock of good quality. The initial formulation of regulations, subject to approval by the State and Federal authorities concerned, as well as their enforcement, would lie in the hands of democratically chosen local boards. Obviously, in so complex and highly variable a technique as forestry, regulations must be localized and flexible in order to meet the silvicultural and economic needs of the forest which vary greatly from locality to locality. Moreover, the formulation of such regulations, if they are to be acceptable, must be by democratic methods in which the forest owners and operators, as well as the public at large and competent technicians, will have a voice. Under this system, the larger forest owners, such as the lumber and paper companies, could employ their own forestry experts and submit for official approval forest management plans that come up to the legally defined standards.

It is clear that in order to keep the machinery simple, the forest conservation districts and the soil and forest conservation districts outlined above should be the combined centers

[1] See footnote page 81.

of cooperation, technical advisory service, and public control. In practice, these various aspects of the forest problem are really inseparable; each aspect reinforces the other, and they all collectively contribute to the only possible kind of solution—namely, a global solution. It may be said of the regulatory part of this program that it represents the "rules of the game" required for the protection of the public welfare, but rules in the formulation and enforcement of which the forest owners will participate and under which they will have a wide latitude for independent initiative and enterprise.

Two ultimate questions arise on this problem of state intervention in the management of private land. One is, What will the people say? The other, What will the courts say?

PUBLIC OPINION AND LAND-USE CONTROL

Our tradition against state intervention in individual affairs, and particularly in property rights, is deeply ingrained. Nevertheless, despite the depth and power of this tradition, an increasing number of people who subscribe to it in theory waive it in practice when they are confronted with conflicts of interest which can be resolved only by such intervention. Specifically, in the face of the wastage of our natural resources, there has been a mounting public concern, but a concern that has been partly futile because of our lack of institutional and legal devices through which it could be channeled into great constructive designs. And even beyond this widespread popular demand for conservation there is a growing willingness of land owners themselves to cooperate in effectively organized democratic attacks on resource wastage. The amazing growth of the soil conservation districts is the most striking example extant. Industrial cooperation in forest regulation under the lumber code is another example. More recently, the organized forest industries, through the National Lumber Manufacturers Association, have on several occasions publicly assented

to the principle of democratic public controls of private forests.

Despite a good deal of heated controversy over the theoretical laws of personal liberty involved in public regulation of land use, the more practical view adopted by moderate people is that both parties at interest—the land owners and the general public—will benefit by the adoption, and if need be enforcement, of reasonable standards of land treatment; and that theoretical conflicts over abstract principles are likely to disappear in an effective cooperative effort to bring order and skill into the use of our natural resources.

From the standpoint of public opinion, therefore, it is not premature to begin to set up the necessary legislation and institutions for democratic land-use control that will at once protect the public interest in natural resources and stabilize and safeguard the economic position of the land users, wage workers, and communities dependent on these resources.

THE COURTS AND LAND-USE CONTROL

But what will the courts say to such state intervention? The Federal government has three broad constitutional powers to regulate land use—its control of navigable streams, its right to regulate interstate commerce, and its right to tax. Deforestation and erosion certainly impair the navigability of streams. Destruction of natural resources impedes interstate commerce and impairs the national welfare. The power to tax implies the use of taxation to promote the general welfare. The powers of the States over natural resources are even broader, being comprised under the wide and sweeping concept of the police power. In addition, the Federal government has certain unexplored regulatory powers under its treaty-making functions, as demonstrated by the Migratory Bird Treaty, referred to below—powers that need further exploration in view of the certainty of international agricultural agreements in the future.

Yet the use of these powers of intervention in private prop-

erty depends not merely on legislation but on court interpretation of that legislation. "The law," Chief Justice Hughes once said, "is what the judges say it is." And the courts change their points of view in response to changing social circumstances and pressures, as is so clearly shown in the recent history of the Supreme Court.

Regardless of political theory, the interpretation of property rights is changing in America. The legal basis of this trend is most succinctly stated in a recent decision by the Supreme Court,[2] which said:

". . . neither property rights nor contract rights are absolute; for government cannot exist if the citizen may at will use his property to the detriment of his fellows, or exercise his freedom of contract to work them harm. Equally fundamental with the private right is that of the public to regulate it in the common interest."

Justice Holmes stated the case even more broadly in a decision concerning river pollution:

"The Constitutional power of the State to insist that its natural advantages shall remain unimpaired by its citizens is not dependent upon any nice estimate of the extent of present use or speculation as to future needs. The legal conception of the necessary is apt to be confined to somewhat rudimentary wants and there are benefits from a great river that might escape a lawyer's view . . . The State finds itself in possession of what all admit to be a great public good, and what it has it may keep and give no one a reason for its will."

And in his classical decision on the Migratory Bird Treaty Act, he eloquently said:

"It is not lightly to be assumed that in matters requiring national action, 'a power which must belong to and somewhere reside in every civilized Government' is not to be found . . . We see noth-

2 Quoted by Philip Glick in his article *The Soil and the Law* in 1938 Yearbook of Dept. of Agric., p. 301. This article is a brilliant discussion of the subject of land-use controls.

ing in the Constitution that compels the Government to sit by while a food supply is cut off and the protectors of our forests and our crops are destroyed. It is not sufficient to rely upon the States. The reliance is vain, and were it otherwise, the question is whether the United States is forbidden to act. We are of the opinion that the treaty and the statute must be upheld."

Though there is undoubtedly constitutional authority for direct Federal regulation of forest and other lands, especially those needed to protect navigable streams, recent experience in Federal-State cooperative legislation, such as the Federal Social Security Act and the supporting State laws, indicates that there are important but largely unexplored potentialities of taking effective national action on national problems through this device. "States Rights," to be sure, are frequently a cloak for do-nothingism. On the other hand, Federal centralization, if carried too far, atrophies local responsibility and leads to rigidity and absenteeism in government. A joint Federal-State attack on the forest problem, operating primarily through State channels, has the advantage of hitching a broad national policy to local administration. And in any event, if individual States fail to live up to the responsibility and opportunity offered by such Federal cooperation, the Federal government, under the legislation proposed, would have authority to intervene directly where national interests are at stake.

CONTRACTUAL CONTROLS

Land-use controls need not necessarily be of the prescriptive type such as those enforced by various kinds of regulatory boards and commissions. There is a wide scope for contractual controls of land use that will become more and more important as governments are forced to intervene in food production to assure their peoples an adequate supply of the foods they need. Important advances have been made in such controls in the United States in recent years. Thus, in the soil conservation

districts, farmers enter into contracts with the district supervisors to practice soil conservation methods for five years in return for technical assistance in installing and maintaining these practices. Under Farm Security loan procedure, borrowers, as part of the loan contract, agree to follow specified crop rotations and soil conservation practices. The Indian Service independently developed the same method of agricultural loans for Indians.

In all three of these cases, the detailed farm management plan, worked out jointly by the farmer and the advisory expert, is the key to promoting a high type of farming and to making and keeping the farmer solvent by making him prosperous. In fact, as developed by the Farm Security Administration and the Indian Service, the farm management plan, adopted as part of the loan contract and kept in force by continuous cooperation between the borrower and the advisory expert, has virtually superseded the mortgage as a basic security for loans, and has made good loan risks of people who would be excluded from access to conventional mortgage credit. A big life insurance company, swamped during the depression by a flood of bankrupt, foreclosed farms, has adopted the same method of advisory supervision in reselling its farms on time payments. The Federal Land Bank at Springfield, Massachusetts, uses its farm loan contracts to maintain the productivity and integrity of farm woodlands against destructive liquidation and employs foresters to enforce this requirement as a basic security of loans. Some European land banks have similar basic requirements in land loans and employ technical staffs to enforce these requirements.

DEMOCRATIC *versus* AUTHORITARIAN CONTROLS

The need for effective social controls to prevent the dissipation of natural resources is only one aspect, though a basic one, of the world-wide struggle to bring a higher degree of

organization and social purpose into the productive economy. World-wide poverty and malnutrition, even in the most advanced countries, is a paradox in the age of science and technology that can be explained only by enormous hidden losses of human energy and natural resources in the frictions of malorganization. But while the heyday of economic individualism has passed, the war has revealed that the democracies, through cooperative mechanisms, can reorganize and systematize their economies without the deadly fascistic regimentation which has made the very word "planning" suspect to democratic ears. It has become clear that whole peoples can pool their resources and energies in gigantic national endeavors, while keeping a firm control of their governments, their officials, and their liberties.

Planning, if it is to free men from poverty and disorder, must be courageous and farsighted; but if men are to be also politically and culturally free, their planning must be democratic and participative. If planning falls into the hands of bureaucratic hierarchies, or superefficient technician and military castes, it will inevitably degenerate into managerial bureaucracy and fascism. Planning can be localized and regionalized, with local initiative and responsibility, and with the central leadership acting as a steering and coordinating device. Nor is planning by any means exclusively a function of the state. There is ample scope for labor, industrial, agricultural, and other groups to assume a large share in economic planning. Such cooperative or quasi-public planning will be a counterweight to the ominous trend in modern times to the rigid, all-powerful monolithic state—a trend that has been forced on government in no small measure by the lack of cooperative initiative and vision on the part of its citizens.

In the realm of our natural resources, land owners and users must bear no small share of the burden of land reconstruction and of scientific management, including the adoption and enforcement of decent standards of land treatment.

The soil conservation districts are a clear proof that the people are prepared to accept both the responsibility of democratic cooperative planning and the self-discipline of enforcing social standards of workmanship and production. They point the way for a much wider acceptance of these two basic steps toward cooperative democracy.

6

A Land Reconstruction Works Corps

In our economic thinking we are still wedded to the belief that private enterprise, in normal times, can shoulder virtually the entire load of production and employment. As a result, we have come to look on public works primarily as a means to relieve unemployment in times of depression and to prime the pump of private industry by keeping money in circulation.

We need a more positive and dynamic philosophy of public works. There are large areas of social need in which private enterprise cannot successfully operate. This is quite obvious of conventional public works like roads, bridges, and flood-control dams. It will become more and more obvious in the broad field of conservation—in the reconstruction and full development of our land and water resources.

It is not true that private enterprise can furnish anywhere near all the goods and services needed by a dynamic modern society. Still more important, the modern trend of economic thinking in the direction of withholding great public works programs for periods of depression, serves to unbalance the economy by overstimulating industrial production and underemphasizing the role of public capital investment in the national economy. A better balance would be obtained if we frankly recognized the need for a continuing, stable program of public works which would regularly employ a part of the available labor supply in fields that cannot be financed by pri-

vate enterprise. On the positive side is the fact that a wisely conceived program of public works builds up our basic national capital.

CONSERVATION AS PUBLIC WORKS

Nowhere is the capital-building function of public works more important than in the conservation of natural resources. From giant hydroelectric dams to the plugging of gullies, from navigation channels to reseeding depleted range-lands, there is awaiting us a great program of public works which will not only add to our national productive wealth, but which will give a better balanced distribution of our available labor and a better balance between private and public employment. Not that the conservation task is by any means exclusively a public one. As shown elsewhere, private land owners, with proper advice and with credit facilities, can do a very substantial share of it. But, as described below, there are also many aspects of the total task that cannot be achieved by private enterprise and that must be done by public agencies if the task is to be anywhere near complete.

The Civilian Conservation Corps was the first major recognition of conservation as a field of large-scale public works activity and investment. The CCC did a surprising amount of valuable work, yet its primary emphasis was the rehabilitation of young men deprived by the depression of normal opportunities for work and education, a fact that served to underemphasize the inherent importance of the conservation job itself. We need now frankly to face the fact that, regardless of prosperity or depression, there is a vast public job of natural resource reconstruction and development that must be organized systematically and continuously over a period of many years in order to stabilize our resources and make them fully productive. So long as this public program confines itself to work

that must be done in the public interest and that cannot be done by private land owners, it cannot be charged with being an encroachment on the field of private enterprise.

PUBLIC WORKS PHASE OF CONSERVATION

The nature of the public works phase of the conservation task itself shows the necessity of organizing it on a systematic and continuing basis. Many phases of land deterioration have gone so far and become so acute that they cannot be remedied by private land owners; other phases of land reconstruction are of an essentially public nature, which the land owners cannot be expected to perform out of altruism. Both these phases of land reconstruction can be classified as public works, whether on public or on private land. There are, for example, millions of gullies that must be "plugged" to stop their gnawing further into fertile land. Immense areas of denuded forest-land must be planted with trees. Thousands of miles of stream channels must be cleared of debris and their banks protected from undercutting. Thousands of small dams, ponds, and reservoirs must be built for upstream flood control. Millions of acres of forest land must be cleared of inflammable debris left by fire and careless logging in order to reduce the general forest-fire hazard. Millions of acres of young timber-land must be weeded and thinned if we are to have a future timber supply. Thousands of miles of forest roads and trails and fire-breaks must be constructed for forest utilization and protection. Great areas of denuded range-lands must be reseeded and water facilities and fences built for grazing control. And there are, of course, the large engineering works, such as dams, levees, and navigation channels, that are ordinarily classed as public works.

These and other physical improvements are essential to soil stabilization, water conservation, flood prevention, and full resource production. They constitute collectively a great body

of necessary public works that are the agenda for a land reconstruction army, a rural works corps, which must be enlisted and used probably for many years in order that the public works aspects of conservation can keep pace with the adoption of conservation practices as a part of the routine management of private lands and with the progress of the larger engineering works on our river systems.

CONSERVATION AND RURAL EMPLOYMENT

Besides its vast constructive importance for the general welfare, the land reconstruction task has an immediate and long-range importance to the economic welfare of the rural population. During the 1930's, there were from 1½ to 2 million unemployed rural workers, the great majority of whom were concentrated in regions of extreme erosion and deforestation. In addition to this chronic unemployment, most farmers, because of the centralization of industry in urban centers, have no opportunity for wagework in the slack seasons of farming and thus constitute a very large body of partially unemployed, partially unproductive workers. The conservation works program would give part-time employment to both unemployed and underemployed farmers.

As the land becomes progressively more productive under this total conservation program, the intensive management of our land resources will support a much larger population. With our extensive and exploitative use of our natural resources, we are very far indeed from realizing the ability of our land to support population. Our continent is half-empty. The "over-population" of rural America is in fact largely made up of the victims of resource depletion, poor land husbandry, and general agricultural maladjustment.

An industrial economy of full production will continue to absorb many rural workers. But also an agricultural economy of full production—including an over-all land reconstruction

program—will absorb a much larger labor force than agriculture now requires. The main answer to rural unemployment is not to glut the urban labor market, but to give the rural population a greater opportunity for employment through a great program of basic land reconstruction which will gradually provide the subsistence for a denser rural population and the raw materials for decentralized, rural industries. We have a curious divergence of philosophy as between urban and rural employment. We consider industry effective and fully productive when it employs the maximum number of workers. We consider agriculture most effectively organized when it feeds the total population with the least manpower. We have looked with equanimity on the enormous relative shrinkage of our rural population in comparison with total population in recent years, as mechanized, extensive, exploitative agriculture has gained momentum. A mature national agricultural policy must give far more weight than it has in the past to farming as a way of life, to the amenities and satisfactions of rural living, and to the capacity of the land, through intensive husbandry and the conservation of all its resources, to support population rather than merely to produce food for the cities.

CONSERVATION WORKS CORPS

Through the organization of soil and forest conservation districts and through the development of conservation credit, a large share—probably half—of the total conservation job can be done at private expense. But the large category of improvements classified above as public works can be carried out only by a systematic, nationally organized, public conservation works program. Such a program will have to be conceived more broadly than past experiments in that direction. It is possible that in the era of industrial readjustment ahead of us, the Civilian Conservation Corps will be reestablished, if only as

a buffer against the normal unemployment inherent in a rapidly changing industrial system. It is possible also that if compulsory military training is continued after the war, a part of the training period could be devoted to conservation work. But in addition, there is need for a localized, flexible conservation works corps that will enroll large numbers of rural workers, who can live in their own homes and be given work at full wages in off seasons of farming. This works corps should be geared into the soil and forest conservation districts as well as into our well-managed but underdeveloped public lands in order to be assured of competent, technical, non-political supervision and of having its efforts devoted to a long-range, integral reconstruction program aimed at stabilizing the soils, waters, and forests of its respective locales.

MAGNITUDE OF EMPLOYMENT IN CONSERVATION WORKS

It is impossible to make anything more than a very rough guess about the magnitude of the land reconstruction job in terms of employment. The National Resources Planning Board [1] has estimated some of the urgently needed work. Soil conservation, erosion control, and runoff retardation on crop- and pasture-land require over one billion man-days. Erosion control and range protection, revegetation, and other conservation improvements on the western grazing lands require 300 million man-days. Forest-fire protection, forest road and trail construction, forest planting and thinning, and other improvements require 500 million man-days. This is only a partial list, but even this program would take 300,000 men about twelve years full time; and if it were done in off seasons of farming, it would employ 1½ million men for ten years or more. Probably, in a full-scale program, it would be conservative to estimate that 2 to 3 million men could be employed part-time for a good many years to come in land reconstruc-

[1] "Public Works and Rural Land Use," September, 1942.

tion, over and above those employed on major river-control works like dams and levees. The number would taper off as land became more productive and as maintenance and intensive management succeeded reconstruction.

Ways and means of financing this proposed conservation works program will be discussed in the chapter on "Financing Land Reconstruction."

PUBLIC WORK ON PRIVATE LANDS

Although the Civilian Conservation Corps did a considerable amount of work on private land, notably in connection with the soil conservation demonstration areas, there was a marked tendency to concentrate its work on the public lands such as National and State Forests and Parks. There was a natural reluctance to spend public funds on private lands, as well as a natural eagerness on the part of public land administrators to improve the properties under their care. Frequently, this led to capital expenditures out of all proportion to the productive value of the land and to the overdevelopment of engineering works like roads and firebreaks without clearcut provision for their future maintenance.

The concept of the conservation works program must be broadened to include extensive projects on private land that are necessary in the public interest and that are not likely to be undertaken by private land owners without assistance. Forest fires and gullies do not stop at land boundaries. Only the widespread thinning of young forests can mitigate the coming timber shortage. Erosional sore spots pour silt into reservoirs and navigable streams. These and other phases of conservation are community enterprises and require a flexible and fair system of public assistance to private land owners. There are numerous precedents for the legality of such public expenditure, e.g., in Federal and State contributions to forest fire, insect, and plant-disease control on private land. As a

basic justification, it is necessary merely to consider, as has been repeatedly brought out in this study, that the conservation of land and water resources requires a unitary and complete strategy rather than piecemeal, fragmentary, and partial efforts; and that to achieve the job in its completeness requires the pooling of public and private resources.

As a rule, private land owners can and will contribute a fair share of the cost of projects which benefit them as well as the community as a whole. Moreover, it is feasible to protect the public investment in such improvements on private land through contract stipulations, such, for example, as the future maintenance of firebreaks or of forest stands that have been improved by thinning.

But it must be strongly emphasized that such a works program on private lands must be confined to organized soil or forest conservation districts, where the work can be intelligently planned, executed, and maintained by virtue of the existence of responsible boards of directors and of permanent technical staffs. A loosely organized, badly supervised, and hastily planned conservation works program would waste money, would be subject to political manipulation, and would discredit public enterprise in this field.

7

Public Acquisition of Low-Grade Land

A STRIKING symptom of our land sickness is the large-scale abandonment of depleted land for tax delinquency. Many millions of acres of such land, with steadily increasing momentum, have come to roost on the doorsteps of embarrassed State and county tax officials—mined-out farm-land, skinned-off range-land, desolate cut-over stump-land. In the aggregate, this abandoned land veritably constitutes a "new public domain." But it also constitutes what might be defined as the great American desert, a shocking symbol of moral and economic chaos in the realm of our basic capital.

A vast aggregate area of land has already reached the stage of abandonment and another vast aggregate area is on the way to abandonment. We are confronted with the alternative of letting this destructive drift go on unchecked, ruining families, industries, communities, and basic resources, or of setting up a broad land strategy designed to overcome these evils.

A part of the answer to the great trend of land depletion and abandonment is to be found in the organized land management district with competent technical advisory services to assist the land owners in conservation management. But that does not get to the root of the matter where the land is already depleted beyond the ability of private capital to restore it, or where it is approaching that stage.

One important factor in this excessive depletion is the form of tenure. Tenant farming and share-cropping is a notorious

mechanism of soil depletion, since the tenant with the insecurity of tenure characteristic of our land-leasing system, has little incentive to conserve the land. In the semi-arid regions of the Great Plains and intermountain region, the homestead laws that were appropriate for the farm-lands of the humid East broke down for the sparsely vegetated grazing lands, since the range cattle and sheep industry required large range units. Moreover, the settlement of the West was marked and is still marked by a great diversity of land ownership. Federal, State, and Indian lands are intermingled with railroad grants, corporate lands, and individual holdings, so that to find a stable land base for grazing enterprise is frequently an extraordinarily complex problem of negotiation and leasing.

So far as the trend to land depletion and abandonment is due to bad systems of land tenure, corrective legislation is needed. The Bankhead-Jones Act, under the administration of the Farm Security Administration, has started an effective attack against the farm tenancy and share-cropper problem by affording long-term, low-interest loans to tenant farmers for land purchase, and this act, over a period of years, may restore the balance in favor of the ideal original system of the small freehold farm. But in the semi-arid West, the tenure problem is far more complicated than it is in the East. Farm tenancy, to be sure, is excessive there. But equally serious, the complex land ownership pattern makes it difficult, and in some cases impossible, for the livestock industry to build up stable and adequate grazing units. This instability has been an important factor in promoting exploitative and destructive overgrazing. The State of Montana has sought a remedy for this complexity of ownership through its cooperative grazing district act, which permits groups of livestock and land owners to organize cooperative grazing districts by the lease, purchase, and management of intermingled holdings.

There is likewise need for the simplification and regrouping of many private forest holdings in order to develop economic

units for sustained yield forest management. For here again the ownership pattern is often very complicated, whereas permanent forest management and utilization are greatly facilitated by having contiguous areas under a single management.

No one can predict, without a great deal of further study and experiment, just how much of our badly deteriorated land can be successfully managed and reconstructed by private enterprise through a better ownership pattern. But with the utmost that can be thus done, there is a great deal of land that has already passed the stage of private reconstruction. The choice confronting the American people is to let that land continue to drift into the category of the great American desert, or to bring it into public ownership and skilful management while there is still enough value in it to warrant public investment.

PUBLIC LAND OWNERSHIP IS NOT "SOCIALISM"

To assuage the fear of the reader that this is a step toward state socialism, it is well to point out, first, that practically all European countries, with centuries of experience with the land tenure and conservation problem, have high percentages of public land, especially forests and grazing commons; and, second, that America has upward of 300 million acres of public land (i.e., one-fifth of our total land area) under competent and almost universally approved public conservation management. Notable in this category are the National Forests, containing 175 million acres, which have been under productive, technical management for over forty years. Much more recent is the technical management of the public domain grazing lands under the Grazing Service of the Interior Department. In less than ten years this administration has made notable advances toward restoring over 140 million acres of western public range-lands and winning the approbation of

the livestock industry and the general public. Even better known and spectacularly popular are the great National Parks, embracing 20 million acres reserved from commercial exploitation as a great cultural heritage of natural beauty. Some 17 million acres of wildlife reservations, under the exclusive or partial jurisdiction of the Fish and Wildlife Service, are dedicated to the conservation and propagation of our native wild game. The Indian Reservations, embracing 50 million acres, much of it in tribal ownership, are likewise under competent technical government management. And many States, counties, and municipalities have made considerable strides in recent years in acquiring lands for public forests and parks, and in some cases for public grazing commons.

These public lands are a rather unique mixed public and private enterprise. They were brought under public administration for very specific purposes—to manage timber and forage for permanent production, to protect watersheds from erosion and floods, to protect and restore wildlife, to safeguard for the use of the people outstanding scenic and recreational landscapes, and to provide public parks and recreation grounds. The complex ecological principles involved in managing these lands for these purposes could be applied only through public administration, and each of these great properties has highly competent technical managerial staffs. But public ownership and management has by no means substituted public business enterprise for private on these lands. The actual business operations are conducted by private enterprise. Thus, the Forest Service sells large quantities of timber to private operators, but it selects the trees to be cut and regulates the logging to assure a perpetual regrowth of timber. The Forest Service and the Grazing Service sell grazing permits to cattle and sheepmen, but with administrative and technical supervision designed to safeguard vegetation and soil from depletion, to rebuild depleted range-lands, and thus to protect our vital water resources from wastage, and to stabilize the

livestock industry. Even in the case of the National and State Parks, most of the hotels and sightseeing and recreational facilities are provided by private concessionaires. In the case of Indian reservations, which are only a quasi-public property held in trust by the government for the Indians, the government has nevertheless, through acts of Congress, reserved the right and responsibility of providing adequate technical management to make these properties permanently and fully productive for the benefit of the Indian peoples.

Anyone who emerges from a desolate wasteland of eroding farms or denuded stump-land and crosses the boundary of a beautiful National Forest into the green expanse of a flower-sprinkled mountain meadow has living proof of what good husbandry can do for our natural resources. The guiding principle is to use the resources fully while safeguarding them from depletion or damage. And the only freedom which the authorized users are deprived of is the freedom to destroy. The freedom of private enterprise in these public lands is thus assured.

HISTORICAL BACKGROUND OF PUBLIC LAND CONSERVATION

The historical causes for the creation of the National Forests and the Grazing Districts of the public domain are pertinent to the solution of the problem of the "new public domain" and its underlying causes. After the Civil War, in the wild enthusiasm for homesteading and "development," Congress carried the current craze of land disposal to an extreme by providing for "timber homesteads." This act led to a scramble, with spectacular frauds, for building up timber properties, especially in the Far West. The liquidation of our Eastern forests by the lumbermen was already in full swing and was already arousing public apprehension when Carl Schurz, great Secretary of the Interior in the 1870's, proposed that the forests of the public domain be reserved in public ownership for timber production and watershed protection. After several

years' agitation of the subject, an obscure rider on an appropriation bill passed in 1891 authorized the President to make such reservations. Staunch, conservative Grover Cleveland, who did not confuse protection of the public interest with state socialism or any other ism, made a notable start in reserving public timber-lands. But it remained for Gifford Pinchot and Theodore Roosevelt to do the job of saving what was left in public ownership of our great western virgin forests from annihilation by the lumberman's ax, and thereby to rouse the American people for the first time to their spendthrift habits with natural resources.

While the National Forests were taking form and for many years thereafter, the unreserved public domain—mostly the endless, undulating grass-lands of the Western Great Plains and intermountain regions—was being grazed and trampled to dust by the wholly unregulated and illegal grazing of millions of cattle and sheep. Congress, following its ancient homesteading formula, had tried to get rid of this white elephant by the grazing homestead act, even though it was obvious in advance that 640 acres was a wholly inadequate acreage to make a cattle or sheep ranch and that the act would be largely a dead letter. Even in the great era of normalcy, public opinion insisted that the government do something to end the ruinous neglect of the public domain which was threatening the precious Western water supply. Secretary of the Interior Wilbur called eloquently for "a great Western strategy" to protect the watersheds and the plantlife on them and to replace "homestead thinking with watershed thinking." But a Federal-State Commission appointed to make recommendations backfired and recommended donating the public domain to the States, which in turn should sell it to the highest bidders. Congress did not act on this proposal, which obviously would have failed to provide the competent technical management required for a "great Western strategy" of watershed protection and at the same time would have violently upset the range livestock in-

dustry.[1] But in 1934 it did act; it provided for setting up organized grazing districts under competent supervision and with the active participation of locally elected grazing boards in formulating policies for regulating and building up the public range-lands. Thus the long task has been started of rebuilding the sadly depleted plantlife and wasted water resources of this vast domain of grass-land, under the technical supervision of the Interior Department.

URGENT NEED FOR NEW PUBLIC LAND PROGRAM

These great public land enterprises were motivated by a common principle—the inability of private ownership to provide the kind of ecological management demanded by these lands for the public welfare. Now we are confronted with the need of an equally great new public land enterprise for exactly the same reasons: namely, the public acquisition, at various levels of government, of a very great aggregate area of low-grade land that was either so poor originally as to condemn private enterprise to failure or has been so depleted that its restoration is beyond the capacity of private enterprise.

There are 75 to 100 million acres of poor farm-land—so-called submarginal land—on which probably 2 million families are fighting a hopeless struggle to make a living and rear families. Some of it is badly eroded land scattered throughout the country; some of it is low-grade hill lands, the poor pickings for the last wave of pioneers; some of it is wind-blown land in the Dustbowl that should never have been plowed and that needs to be put back into grass and organized into range units; some of it is farms helplessly stranded in the midst of great areas of devastated forest whose exploitation ruined the regional land economy. This run-down, low-grade land not

1 See *Report of the Committee on the Conservation and Administration of the Public Domain*, Govt. Printing Office, 1931; also Ward Shepard, *The Handout Magnificent*, *Harpers Magazine*, October, 1931.

only keeps large numbers of people in chronic poverty, but in the aggregate contributes substantially to agricultural overproduction. The bulk of it cannot be restored by the owners either because it is too far gone and requires a prohibitive capital investment, or because surrounding timber and grazing lands have been so depleted as to have undermined the entire local economy. Probably a part of this land could be rehabilitated by the owners if they could be employed part time in a public land reconstruction program designed to rehabilitate the predominant wasteland. Probably a part of it could be organized as cooperative grazing districts and restored by cooperative action, with competent technical guidance. But even with the utmost private effort there will remain a very large area that can be restored only through public ownership and management. Even so, not all this land need remain permanently in public ownership. No doubt part of it could again revert to private use or ownership after a lengthy restorative treatment and under adequate safeguards to prevent its relapse into land sickness.

Within the Federal Grazing Districts and the National Forests is a large aggregate area of alienated land much of which should be brought into public ownership. This alienated land greatly complicates the administration of the public lands with which it is intermingled, and much of it is of such a character that it will receive proper care only under public administration.

Many of the Indian Reservations have been riddled and gutted by sales of land to whites. These lands must be purchased and restored to Indian use if the Indian peoples are to have a chance to rise above the level of extreme poverty. While this is not a strictly submarginal land purchase program, it must, in justice to the Indians, be fitted into the total land purchase program.

There is a very great aggregate area of cut-over or depleted second-growth timber-land the owners of which cannot or

will not put it into productive condition. There are great areas of mountain and hill forest that are needed for watershed protection, flood prevention, and water conservation. There are large aggregate areas of virgin timber—scattered tracts in and about the western National Forests and great areas of Douglas fir and redwood which are being for the most part destructively liquidated by private industry, with ultimate tragic results to our West Coast economy. All told, probably 150 million acres of these various types of forest need to be brought into public ownership for reconstruction, permanent production, watershed protection, and the stabilization of regional economies against continuing depletion of natural resources. Above all, the forest purchase program should strike at the heart of the forest problem, namely, the rapid acquisition of a large area of young and middle-aged timber of reasonably good quality before it is damaged beyond redemption.

PUBLIC ACQUISITION OF VIRGIN FORESTS

In this public purchase program, it is vitally essential that the virgin redwood forests of California be brought into public ownership without delay. Fifty years of experience clearly shows that these noble forests, one of the most superb works of nature, cannot be properly managed by private industry. Their further liquidation by clean cutting would be a demonstration of social callousness and esthetic blindness. We are not so poor in money or spirit that we need to destroy the ancient glory of the redwoods in pursuit of material comfort. About one-third of these forests should be kept as National and State Parks, the rest as National and State Forests to be managed on a system of light selective cutting that will not impair their productiveness or seriously diminish their beauty. The present ownership pattern does not make sense, either industrial or social, since the liquidation of these forests by and large has not been financially profitable. Public ownership, as here sug-

gested, will be of great advantage to the redwood lumber industry, and will permit the people to exercise a moral trusteeship over one of the world's greatest natural treasures.

The further despoliation of the great Douglas fir and other virgin forests of the Pacific Northwest is equally meaningless and needless, both industrially and socially. These forests contain about half our remaining supply of sawtimber and they are being liquidated at an excessive speed and with very inadequate provision for regrowth when cut. The industrial owners are under the burden of heavy carrying charges of interest, taxes, and protection, which force them to overcut and frequently to abandon cut-over land. Only public ownership is capable of the orderly conversion of these virgin forests and the carrying of the cut-over lands until the young timber is mature, and both the biological and economic factors dictate that the bulk of the northwest timber-lands be in public ownership, Federal and State.

For over thirty years there has been a modest Federal forest acquisition program which has added a few million acres to the National Forests, mostly in the East. For ten years there has been an equally modest program of "submarginal" land purchase. At the present rate, it would take centuries to do the minimum public acquisition program waiting to be done, and by that time erosion, forest fires, and destructive exploitation would have ruined most of the land to be purchased beyond any possibility of redemption except at heart-breaking cost.

Although the above discussion puts the main emphasis on the public acquisition of lands that cannot be effectively managed by private owners, it is not to be inferred that all needs for additional public lands are limited to this category. Expanding industrialism and concentration of population dictate a far more extensive and well-distributed system of public parks available to all parts of the country. Our system of wildlife refuges, especially the nesting, resting, and feeding grounds for migratory waterfowl on the great natural flyways of migra-

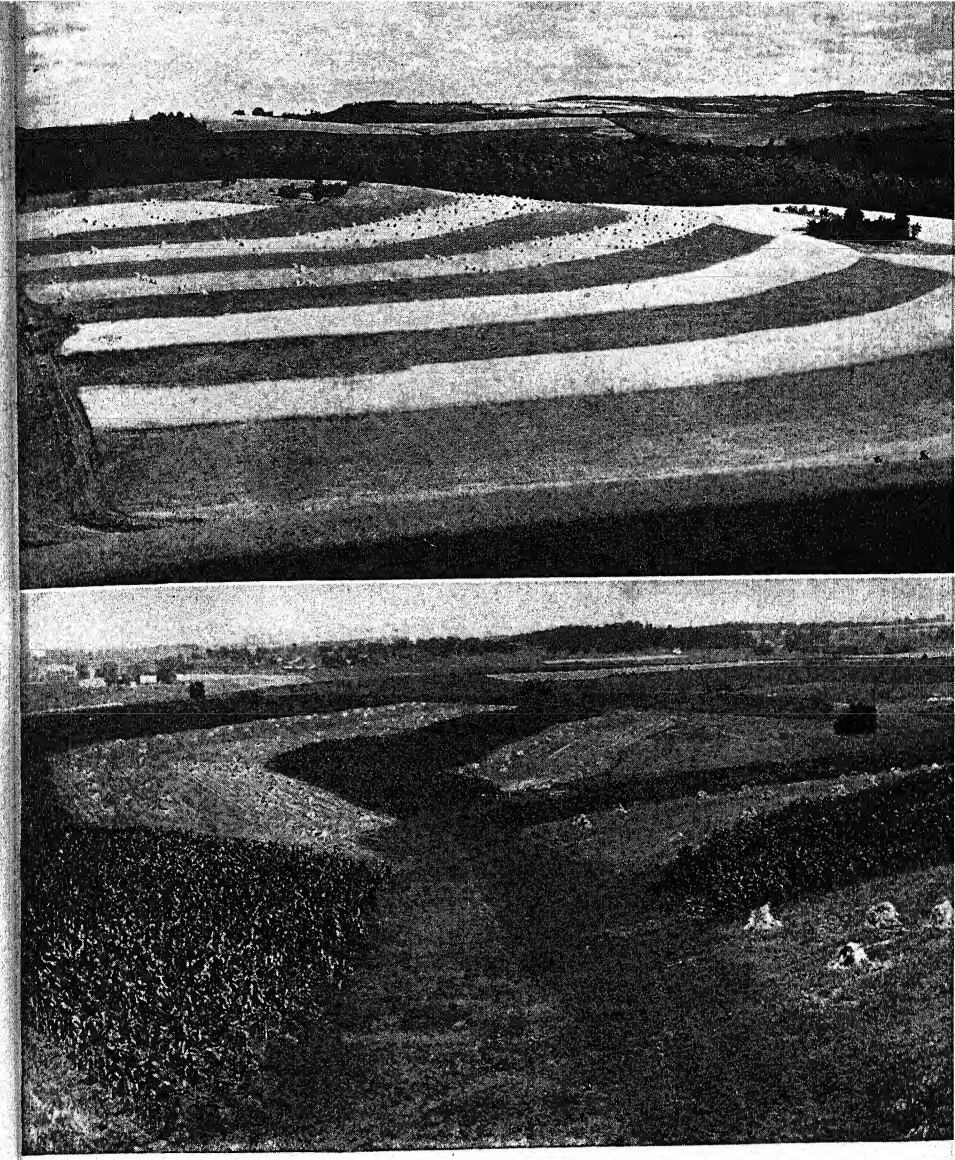
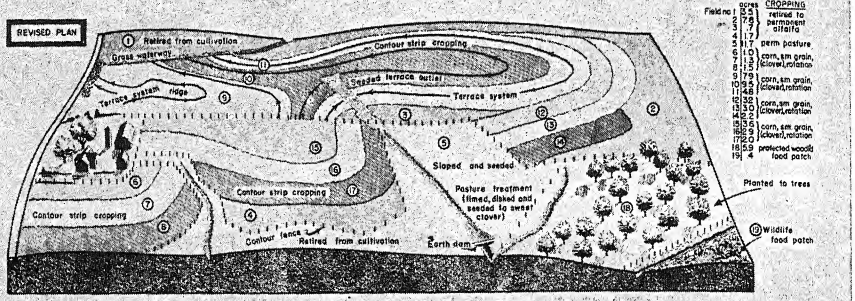


PLATE 7. Before the advent of the Soil Conservation Service, no one had fitted together into a coherent whole all the measures needed to control erosion and runoff over whole farms and watersheds.
Upper. Contour cultivation and strip cropping.
Lower. A grassed waterway designed to carry surplus rainfall safely.

SOIL CONSERVATION

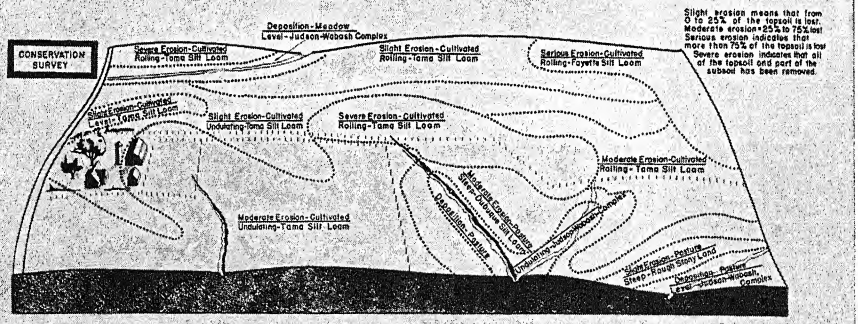
CALLS FOR DEFINITE LONG-TIME PLANNING



- Proper Land Use for Each Acre
- Crop Rotations with Legumes
- Contour Tillage—Strip Cropping—Terracing
- Trees and Shrubs for Badly Eroded Areas
- Small Gullies Sloped and Seeded
- Grass Waterways in Natural Draws

EROSION CONTROL

STARTS WITH AN INVENTORY OF FARM RESOURCES



The Soil Type, Slope, and Extent of Erosion Must Be Considered in a Comprehensive Control Program. Erodible Soils on Steep Slopes Are Particularly Subject to Heavy Losses. These Factors Affect Both Vegetative and Mechanical Conservation Practices.

PLATE 8. The detailed farm management plan, fitting into the broad watershed control plan, is the key to the scientific reorganization of world agriculture. Civilization can no longer ignore the urgent necessity of applying scientific management to all land.

tion, is far from complete. With our abundant land resources, these and other public needs can be met without impairing our agricultural economy.

We cannot afford to let 300 million acres of land (a sixth of our whole land area) lie practically fallow, untended, unkempt, and deteriorating, over a period of generations. In order to put our rural house in order, the job of public land acquisition must be attacked with the energy and vision that went into creating the National Forests and the Grazing Districts. And as will be brought out in the chapter on Financing Land Reconstruction, the purchase cost, if handled by proper fiscal principles, will be practically nil. This purchase program should be worked out on a cooperative basis with the States and provide for a balanced system of Federal, State, and local public land projects. Thus part of the purchase program can be undertaken by the soil conservation districts as well as the proposed forest conservation districts; for, although those districts will always be composed preponderantly of privately owned land, the bulk of them will contain substantial proportions of low-grade lands that are not suitable for private operation and will remain a drag on the district economy unless restored to production. The public lands thus provided in the districts would be under the administration of the boards of supervisors, whose permanent corps of advisory technicians will provide the necessary technical administration of the public lands as well as advisory service to the private land owners.

ECONOMIC BENEFITS OF PUBLIC ACQUISITION PROGRAM

The bulk of this total purchase program would be in the Eastern States, where the submarginal and deforested land problems are most acute and extensive, but there is also need for substantial public land acquisition in the Great Plains, the Rocky Mountains, and the Pacific States. Beyond its immediate economic objective of safeguarding these lands from

further depletion and restoring them to full production, this program would give to the densely populated industrial East a great system of well-distributed national, State, and local parks and forests, grazing commons, and game preserves, all or most of which could provide much-needed outdoor recreational facilities within easy reach of the entire population. Their restoration and subsequent productive management would also provide raw materials to private enterprise and constructive wagework for rural workers and thus be an important balance-wheel in the rural economy. Thus, in northern Michigan one small public forest operated for the sustained yield of timber is able to give twenty-eight neighboring farm families each a minimum of $500 wagework a year, paid out of the profits of the enterprise. Throughout Europe for generations the peasants have had regular winter wagework in harvesting and caring for the magnificently managed, continuously cropped forests, which are just as much a part of the agricultural economy as field crops and livestock.

PAYMENTS IN LIEU OF TAXES

A knotty and only partly solved problem of the public lands is how to reimburse the local tax units for the loss of taxes on land taken off the tax rolls. The problem partly disappears when subjected to analysis. Worn-out, skinned-off land tends everywhere to be abandoned for tax delinquency; and if the public agencies buy it and employ labor to restore it, and if its restoration will gradually rebuild local resources and industry, the local tax units would obviously be better off even if the government made no payment in lieu of taxes. The basic fiscal problem confronting communities threatened by natural resource destruction is not the loss of land from the tax rolls through the creation of public land reserves, but the depletion or destruction of private lands through exploitative methods that drain off the economic lifeblood. Nevertheless, the great

Federal land-managing agencies do make payments to the States and counties in lieu of taxes. The National Forests, for example, pay 25 percent of their gross receipts to the counties within which they lie. But even this payment does not answer the whole problem. For example, a large block of National Forest timber might be held for fifty years before it was ripe for cutting, and meantime it would yield the county no revenue. There is need for working out a formula for uniform payments from Federal lands to local tax units on the basis of the net income value of the property and for putting these payments on a uniform annual basis. It is essential to do justice to local communities; but on the other hand, these communities ought not to expect returns out of all proportion to the value of the property, especially when the property is being restored for the permanent benefit of the local people as well as the nation.

The complete solution of this problem goes even deeper. Opponents of public land purchase make much use of its effects on the local tax structure to oppose or block further public ownership, regardless of whether such ownership is essential to protect the general interest. This is putting the cart before the horse. The basic question is, Can or will any type of ownership other than public ownership restore such lands to economic production or keep them in production? Obviously, the question of productivity takes precedence, both for public and for private interest, over the exact form of taxation. For if certain types of land are inevitably destroyed in private ownership—and the tendency to destruction both of forest and semi-arid grazing land is world-wide in the absence of effective public management—then quite obviously any kind of taxation of such land becomes impossible, for there is no productive value to tax. To insist, in the light of the ominous trend to land bankruptcy, on obscuring the real issue behind an unrealistic, die-hard defense of a tax method that is unworkable, is merely doctrinaire.

The real solution of the tax problem is to alter the method of taxation on these lands. The beneficiaries of the public lands should pay additional taxes to offset, at least in part, the loss of property tax revenue on these lands. There are several reasons why they should pay such taxes. In general, grazing fees and in some cases timber prices on the public lands are below their true market value. This difference could well be absorbed by the local tax authorities. Moreover, the users of the public lands are reaping the benefit of the services of highly trained technical staffs, whose job is to make these resources permanently and highly productive, and they are granted valuable use-rights, preferences, and contracts, which reflect themselves in stable and permanent private enterprise on expertly managed public properties. These advantages, privileges, and securities have a definite, tangible, monetary value, as is proved by the fact that when livestock outfits grazing on public lands are sold, the seller almost invariably gets a very substantial cash bonus to cover the value of his special privileges as a user of public lands. Those who are concerned over the withdrawal of public lands from the tax roll could well consider this potential source of tax revenue. The public agencies could well continue to pay a ground tax on the lands under their administration, which added to the increased and permanent income tax on the users of these lands, should yield whatever tax revenue their productivity warrants. Beyond this point, taxation, in the long run, cannot go; it is impossible to get blood out of a turnip.

The program of land purchase and restoration here advocated would be an important balance-wheel in our economy. It would bring into permanent production, on whatever scale of intensity our national need justified, a great area of land that is otherwise headed for the scrap-heap. At some later time, if and when population increase justifies, some of this land could be restored to agricultural production, after its fertility had been built up by two or three generations of good man-

agement. Meantime, it would relieve agriculture of the pressure of overproduction on lands not needed or not suitable for agriculture, and would concentrate production, by more intensive methods, on the better grade of agricultural lands. Our national erosion problem is, in part, a reflection of our historic overabundance of land. It was always easy, until the turn of the century, to skin off the fertility of the soil and break new soil in its stead. We have already paid a gigantic penalty for this waste. Conservation farming represents the swing from extensive to intensive agriculture. It means more work, and especially more intelligent work; but it means also more production and cheaper production. It means that more people can be supported on a given area of land and that more people can be fed from that area. But, equally important, it means stabilizing our agricultural plant for permanent fertility and production. Given the fact that America has, in modern times, farmed a greater acreage than on the average has been needed to meet the market demand, and that conservation will intensify and increase the production of our farms, the retirement of low-grade farm-land by public acquisition and its devotion to other uses will form an important balancing mechanism against overproduction of crops. And the rebuilding of these lands as forests, parks, game refuges, and grazing commons will provide wagework for rural workers, will increase the value of our water resources, and will lay the foundation for a timber supply against the inevitable and drastic shortage that will be the penalty of our long and fatal policy of deforestation.

8

Financing Land Reconstruction

To STABILIZE our soils and waters, to repair the damage already wrought upon them, to recreate the fertility and fecundity of our farms, forests, and ranges, to tame our floods and to capture and harness our rivers—these constitute a gigantic national economic-engineering enterprise comparable in magnitude with the original conquest of the continent. We have made measurable progress in the different segments of the enterprise, but the progress has been spotty and piecemeal and nowhere has it overtaken and passed the destructive downward trends of misuse. In our intense preoccupation with short-range economic problems, conservation has appeared remote and impractical and conservationists have seemed to be the prophets of a doom that is too distant to take much thought about. The range of problems involved has seemed too vast for human effort or at any rate too costly. Even if the technological problems have been or can be solved, even if we admit that a total conservation plan is the bedrock foundation of our national prosperity and stability, where is the money coming from to finance such an unprecedented work?

In broad terms, the answer is that this job is mainly one of capital investment. In one aspect it is the reinvestment of wealth expropriated through several generations of overexploitation of the earth and its resources. But in the larger aspect, it is investment to insure a higher return on our natural

resources and to make that higher return permanent. In the long run that investment will pay for itself many times over. There is no human enterprise in which we may more safely invest our national energies and from which we can be assured of more generous and regular dividends than in safeguarding the fertility of the earth and the bounty of nature.

We must, however, adopt a method of financing this investment that will be suitable to the magnitude and the long range of the conservation enterprise. If we wish to expand our industrial plant or construct a system of transcontinental railroads or create a merchant fleet, we do it through capital financing. We can do little more than nibble at conservation until we approach the financing of land reconstruction and flood control from the same standpoint. The job is too big and long drawn out to pay out of current national income, public and private. Trying to pay for it out of current income is merely fiddling while the basis of our civilization is melting away. It will take to the third and fourth generation to pay for the sins of land destruction. Only a sound, long-range system of capital investment, mapped out in advance and with adequate provision for a steady flow of funds, will do the job.

The annual appropriation system, even if it could provide the funds, is ill adapted to such long-range continuity of financing, subjected as it is to the frequent policy shifts of legislative bodies. So-called "deficit financing" has the objection, among others, of perpetuating political struggles over the issue of balancing the budget, which would subject a rural economy based on a long-range conservation program to the instability of fluctuating decisions.

An even stronger reason for frankly and wholeheartedly adopting the principle of capital financing of conservation is the need to bring the function and importance of our natural resources into line with the rest of our national economy. While all the resources of enterprise, science, and finance are

brought to the upbuilding of industry, we are content to treat agriculture and natural resources as a side-show, operating largely on primitive rules-of-thumb. We take these resources for granted, or stand helplessly by while our soils are eaten away by erosion, our grass-lands are turned into deserts, our forests are denuded and fire-blackened, and our swollen and silt-laden rivers rage to the sea. Bringing these vast national resources out of the primitive economy of overexploitation, waste, and ruination means not merely a revolutionary application of scientific methods of land and water management, but it means abandoning a niggardly and pinch-penny attitude toward these irreplaceable resources, and adopting national programs worthy of the scope of the problem involved, financed by means capable of achieving the end.

NATIONAL COST-ACCOUNTING

As a first step toward the capital financing of conservation, we need for the governmental share in the enterprise what has been called a system of "national cost-accounting." Technically, this means we need a system of public bookkeeping, such as some of the Scandinavian countries already have, to segregate current running expense of government from capital investments. Large parts of the public conservation enterprise—such, for example, as flood control, hydroelectric development, the installation of conservation farming, the stoppage of gullies, engineering works for stream bank protection and for the safe disposal of surplus runoff, forest firebreaks, and public land acquisition—are strictly capital investments rather than current costs of operation. Under an adequate system of national cost-accounting, such long-time constructive investment aspects of the enterprise can be segregated from the day-to-day administrative and operational costs and could be systematically financed by conservation bond issues. A part of the

conservation issues can be directly amortized from receipts, notably the land acquisition program from the sale of timber and forage and a good deal of the flood-control program through the sale of electric power and water. The rest of these issues can be amortized from increased tax yields through increased productivity of our land and water resources, for in the present chaotic and deteriorating condition of these resources they fall very far short of their wealth-producing potential and will deteriorate still further unless a program of global amelioration is undertaken. These investments can also be offset by savings in subsidies to distressed farmers and in economic losses or emergency expenditures caused by floods, droughts, agricultural bankruptcy, work relief, and other symptoms of a disjointed rural economy.

THE INFINITE VALUE OF LAND

If we wish to create a natural resource base that will permanently support a great and dynamic civilization, we can do so only by directing an appropriate part of our energy and will to that purpose. In a system of national cost-accounting, the money "cost" of the conservation enterprise is merely a measure of the human energy expended to recreate and maintain the fertility and fecundity of the earth. If the initial investment cost is spread over a reasonable period of time, it is a bookkeeping entry that will be more than offset by the greatly increased wealth which stabilized and tended natural resources will produce.

Mass production in industry is an interesting parallel to the mass production in agriculture under a total conservation program. Mass production is essentially an intellectual construct, an integrated system of ideas that controls the flow of raw materials and processes in a completely articulated pattern. This intangible systematization of ideas has produced the miracle

of American war production. Or, to take a concrete example, it results in producing a streamlined V-8 Ford for $600 or $700, whereas in 1905 a primitive handmade model cost over $2500. The "cost" of the engineering skill that creates mass production is actually an enormous saving.

So in the completely systematized and articulated technologies of total conservation, the "cost" of scientific management disappears and emerges as more abundant production at lower costs. More important, in the long run, it is the difference between national prosperity on the one hand, and stagnation and impoverishment on the other.

Well-meant efforts have been spent in trying to devise a calculus to determine whether or not it "pays" to conserve this or that acre of land, depending on the market "value" of that land in comparison with the "cost" of conserving it. Considering that the earth can continue to be inhabited by man for endless ages and generations, the value of a given acre of land is literally infinite, and the amount of money we can afford to spend to conserve it is limited only by its potential long-range productivity and by the amount of human energy available to conserve it. Any other view of land value is moral nihilism, since it tolerates the destruction of the capacity of the earth to support human life and thus destroys human life itself. Interpreted in terms of practical action, the principle of conservation means that we must set as a minimum social base level the dictum that land deterioration can no longer be tolerated and that above that base level, we must progressively restore land to as full productivity as national needs dictate. This principle of halting the downward trend of natural resources must become the basic axiom of a new system of agricultural economics and agricultural policy. For no system of production is worthy of the name "economic," which in its very derivation implies order and thrift, if it consumes its basic capital as fictitious income.

THE SOURCE OF CAPITAL FOR LAND RECONSTRUCTION

The use of credit to finance land reconstruction and water control means the use of some of our surplus capital to direct human energy into new channels. There is abundant capital for that purpose. Most industrial expansion in America in recent years has been financed out of undistributed profits and depreciation reserves, a fact that has accounted for the steadily growing backlog of idle savings accumulated by banks and insurance companies. There is nothing surprising about this accumulation. It would be frivolous for an adult civilization to invest all its savings in the indefinite multiplication of industrial plants and relatively little in the resource base. The dammed-up capital being accumulated through the savings of the people cannot all be wisely or safely invested in the indefinite expansion of industry. There are limits to the demand for consumers' goods, and in the long run there are even more rigorous limits, in dwindling natural resources, to the wasteful consumption that is immaturely confused with "abundant living." America has shown some signs of repletion in recent years with the materialistic ideal, which may portend a willingness to invest more of our national energy (i.e., capital) in less tangible cultural goods, including the productive and esthetic culture of the earth. But even in the strictly economic and financial sense, a great investment opportunity of the future will be in land reconstruction and water-control development.

Surplus capital can be siphoned into the conservation task by two broad devices—one, the floating of bond issues for public conservation work and land purchase; the other, the development of conservation credit available to private land owners.

Hansen and Perloff (see footnote, p. 169) forecast the need for an annual public investment of about two billion dollars in regional resource development for about thirty years,

mostly for land, water, and power development. A good deal of this budget, however, is not chargeable strictly to conservation, but to developmental activities such as hydroelectric power production. There exists no adequate basis for an estimate of the needed conservation investment. The time allotted for completing the conservation investment should, however, be considerably reduced from the Hansen and Perloff time allotment of thirty years for the total developmental program. It is vitally essential that erosion and water-wastage be substantially checked on our entire land surface before the major investments in large reservoirs and other river developments are completed, since such developments are rapidly impaired by siltation and floods. It is therefore suggested that the public land acquisition program be financed so as to be completed in ten years, the soil and forest conservation districts be completely organized in twelve to fifteen years, and the conservation works program be completed in fifteen to twenty years.

FINANCING THE SOIL AND FOREST CONSERVATION DISTRICTS

A prime requisite for a total conservation and flood-control program is to discover ways and means to finance the necessary technical personnel for the rapid completion of the existing soil conservation districts and their extension to the entire country. To provide the necessary personnel would require a considerable expansion of the technical and operational personnel of the Soil Conservation Service; in addition, it would require a special training in soil conservation technologies for about 2300 men a year over a period of twelve years, and adding these men to the district staffs as technical aides as their training is completed in order to assist farmers in reorganizing their farms for total conservation. A staff of this magnitude, however, is not permanently required, inasmuch as the advisory staff in each district can be sharply reduced after the

complete conservation program is installed and working smoothly.

The forest conservation districts will require a permanent staff aggregating several thousand men for the country as a whole. However, not all the cost of maintaining this advisory staff need fall on the public. Under properly drawn State forest control laws, the larger forest owners can be required either to maintain their own technical staffs or to reimburse the government for the use of government forestry technicians. In various European countries the practice is followed of "charging what the traffic will bear" for this type of public technical service. Moreover, many European countries support their agricultural and forestry extension services by a special land tax, giving the land owners, through elected boards, much authority and responsibility for the development of extension work.

It should be possible to work in this direction in the United States. It has been emphasized in this study that competent technical land management must be provided for our entire land area as a basic safeguard of the public welfare. The cost of providing technical advisers to help land owners adopt such management should become a recognized part of the cost of production, just as management is a cost in industrial commodities. A processing or excise tax on farm and forest products to pay at least a part of the cost of a managerial advisory service would be one method of giving effect to this principle. This cost-sharing between land owners and the public of an adequate land management advisory service may be the only means of obtaining enough funds to finance the undertaking completely. But whether or not a cost-sharing plan is developed now or later, the principle should be followed of providing for the long-term financing of a complete soil and forest conservation advisory service as an indispensable part of the flood-control and watershed development programs. If this service cannot be financed entirely from current appropriations (and

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it probably cannot be in the relatively short period during which it is imperative to get it fully organized), the cost should be met as a necessary part of the long-range financing of the nation-wide flood-control and river development program.

To embark on a gigantic program of flood control and river development without a complete correlative program of soil and forest conservation throughout the river drainage basins would be to invite disaster. Quite aside from the urgency of conservation of and in itself, there is no justification for making huge engineering investments on the main river stems without safeguarding them against destruction by siltation and excessive floods. Control of runoff and erosion over the entire land surface of river drainage basins is the only insurance against the premature and costly liquidation of the engineering works. Consequently, the financing of the conservation program is the *sine qua non* of any prudent approach to these great social investments. Without it, we shall be doing less than half a job; for, without it, the regimen of our rivers will steadily deteriorate regardless of the expenditures that may be lavished on engineering works alone.

Financing technical personnel in the soil conservation districts will meet only a part of the financial needs of the districts. The boards of supervisors urgently need credit for the purchase of machinery, such as tractors, bulldozers, terracing machinery, and the like. They also need credit for the cooperative purchase of fencing, seeds and fertilizers, and farm supplies and equipment to be sold to individual farmers. Loans for machinery can be repaid by charging land owners for the use of the machinery on their own land. Loans for the cooperative purchase of farm supplies and equipment can be repaid through the resale of these commodities to individual farmers. The soil conservation districts are one of the greatest cooperative enterprises in the world. Their success hinges in no small measure on the adequacy of funds for technical personnel and

credit facilities for financing the necessary farm reorganization. It is vitally essential that the organized soil conservation districts have full access to credit from the Farm Credit Administration, both for use by the district supervisors and for relending to individual farmers.

There is no realm of agriculture where credit will be more productive or more secure. Probably half the total cost of land reconstruction can be paid for by private land owners if effective systems of credit and contractual bargaining are set up. It would be unfair to expect them to bear all the cost. Land depletion is the result of a pioneer exploitative social system for which we must all assume a share of the consequences, and its incidence is too heavy and too widespread for private land owners to bear in its entirety.

But land owners can bear their share only if conservation credit facilities are made available to them. There is a special need for a system of low-interest conservation credit for long-range conservation improvements like terracing and forest thinning. This principle should be extended to all the more difficult phases of private conservation, such as terracing, the moving of fences, gully stoppage, and the like, the cost of which must be spread out over a considerable period of time if the average low-income farmer is to do the work at all. As a further inducement and as a recognition of the public benefit derived from such work, the rate of interest should be low, possibly 2 percent. Such credit would greatly stimulate rural employment in the private conservation program, and more important, it would greatly speed up the rate at which the conservation job can be achieved.

FINANCING SOIL CONSERVATION ON PUBLIC LANDS

Recently a small part of the Soil Conservation Service personnel and funds were transferred to the Interior Department

for soil and water conservation on the public lands and Indian Reservations under its jurisdiction. The personnel and operating funds available are wholly insufficient to do the job. In the National Forests also the funds available for such capital investments as the reforestation of burned or denuded areas and adequate forest-fire control improvements, are insufficient to meet the needs of watershed protection. Two reasons imperatively dictate adequate funds for these purposes. One is that government neglect of the unreserved public domain and the Indian Reservations over many years brought large areas of these lands to the verge of ruin and the government must now repair the results of that neglect. Another is that the great bulk of government land—namely, the National Forests and the Federal Grazing Districts—occupy very strategic sites for controlling the regimen of many of our great rivers: the one, the great western mountain ranges, with their heavy precipitation of rain and snow; the other, vast semi-arid grass-lands highly susceptible to devegetation, dessication, and wind and water erosion. Billions of dollars have been or will be invested in irrigation and hydroelectric developments that will get a part of their water from these lands. This investment must be protected by a thorough-going conservation program on the land surfaces tributary to these projects. Quite obviously, the rebuilding of its own depleted lands is not only a first obligation of government trusteeship, but it involves the least conflict with private vested interests and consequently permits the most rapid advancement. The principles of capital investment and national cost-accounting are peculiarly applicable to these public properties.

Here again whatever share of the costs of rebuilding these lands cannot be met from current appropriations, should be provided out of the long-range financing of our river development projects as an insurance against their premature liquidation.

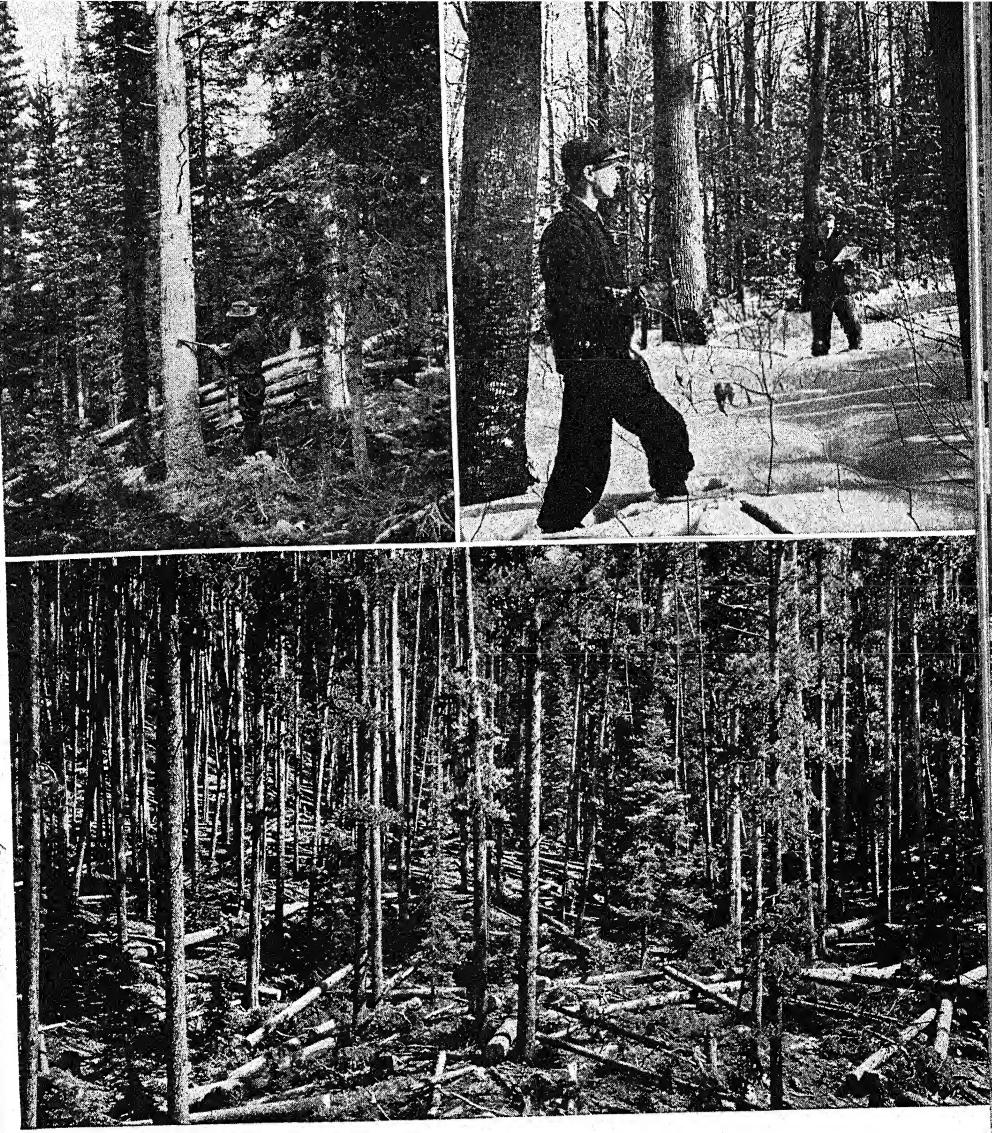

PLATE 9. Permanent forest production requires expert technical management and long-range planning.
Upper left. Forester marks trees to be cut.
Upper right. Technicians make scientific inventory of forest.
Lower. Proper forest cutting removes mature trees while leaving a vigorous, growing forest.

PLATE 10. Forest destruction is a fatal weakness in our agricultural and flood control policies.

Upper right and left. The majestic redwoods are being "liquidated" by private ownership.

Lower. Sawmill based on a permanent timber supply from National Forest. Public forests spell community stability.

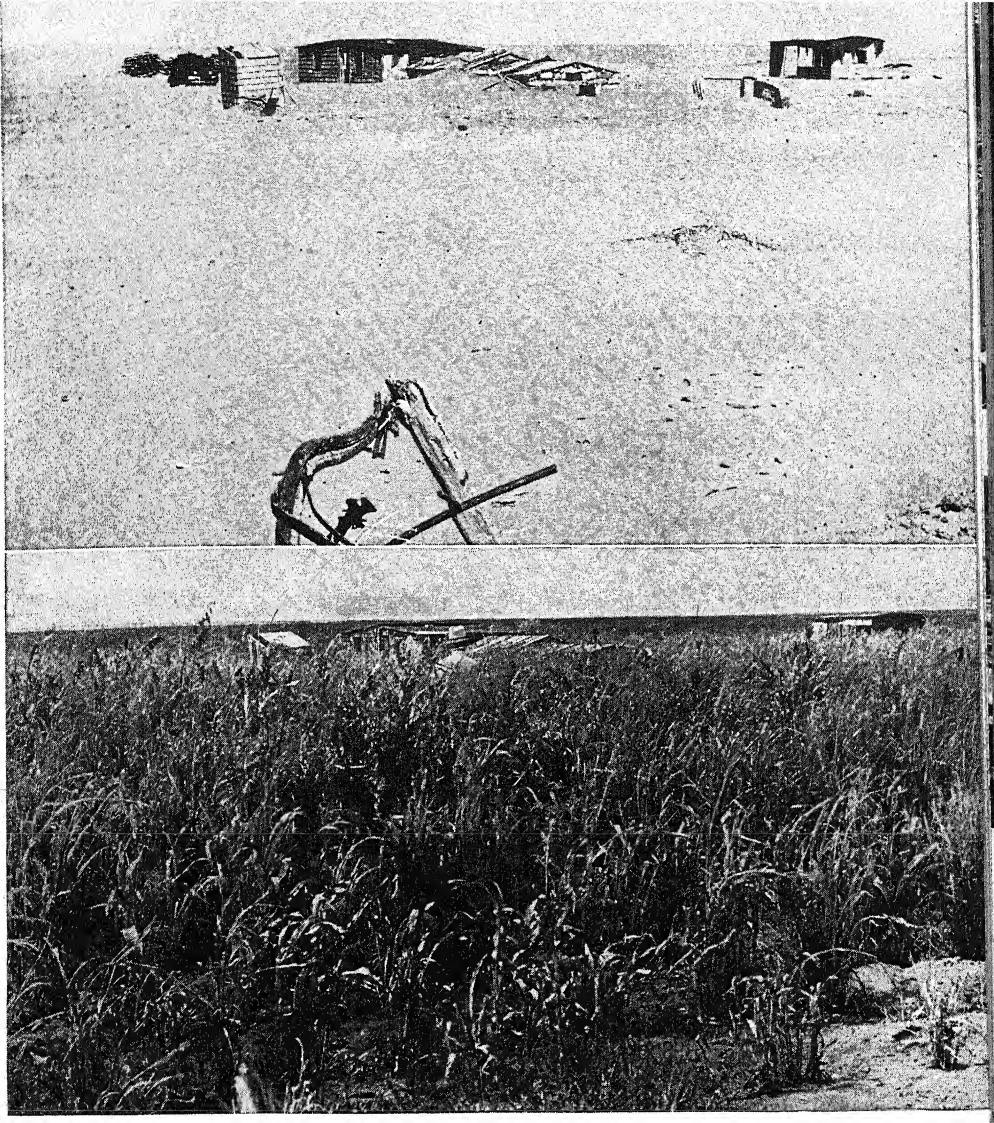

PLATE 11. Great areas of denuded farm, forest, and range land must be brought into public ownership for rehabilitation and flood control.

Upper. Ruined farm in Colorado included in submarginal area purchased by Soil Conservation Service.

Lower. First step in soil restoration.

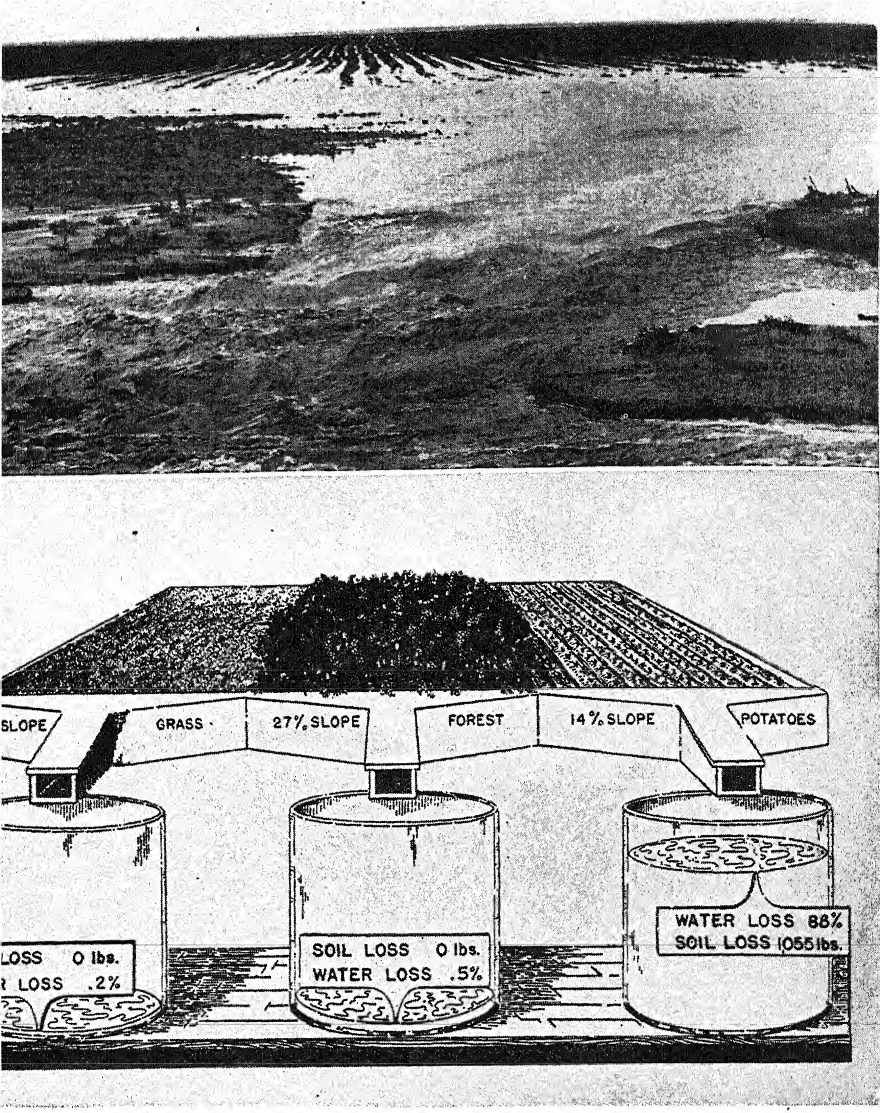

PLATE 12. Mismanaged land makes our flood problem unmanageable.
Upper. Rainfall rushes from field plowed up-and-downhill.
Lower. Vegetation holds soil and water. (See p. 147.)

FINANCING THE CONSERVATION WORKS PROGRAM

Between the two world wars, and especially during the depression, farm income was so seriously depressed that resort was made in the agricultural adjustment program to large-scale subsidies to farmers, principally in "benefit payments" for specified conservation practices, such as using lime or planting soil-building crops like legumes and grass in place of soil-depleting crops like cotton or corn. The need for such supplemental farm income has been principally ascribed to the loss of world markets after World War I, and to overproduction or underconsumption at home. Undoubtedly these were important basic causes of agricultural depression, but another deep-seated and less recognized cause was the steady depletion and deterioration of our entire agricultural plant by deforestation and erosion. Another cause was the decline of rural wage-paying industries through the urban centralization of industry. The vast majority of farmers have been and remain merely part-time workers.

The decentralization of industry out of urban areas and the upbuilding of rural industries that will absorb some of the slack time of the rural population, will depend in no small measure on the equitable and wisely planned distribution of hydroelectric power. Such an industrial decentralization, however, is a long-range task, hinging on the rate at which we bring our river systems under control. Meantime, a conservation works program, which can absorb part of the surplus time of the rural population, is dictated by the overwhelming urgency of getting our great river drainage basins in order as a basic phase of the water control and river development program. Obviously a systematic conservation works program will be a partial means of insurance against a possible future slump of agricultural income.

The agricultural crisis of the 1930's made some form of farm subsidy imperative. As an emergency measure to tide over this crisis, public opinion at least passively accepted the costly program of benefit payments by the Agricultural Adjustment Administration for conservation measures of a rather elementary and incomplete type as contrasted with the integral and complete program of the Soil Conservation Service. As a long-range policy, however, a subsidy program, even in the guise of payments for practices that directly benefit the farmer, has the moral objection that inheres in unearned income and, more practically, it has the political weakness of instability and uncertainty, since it depends on the acquiescence of the tax-paying public as a whole.

Moreover, because of the vast aggregate subsidies granted for incomplete and partial conservation practices, the actual progress toward the solution of our conservation problem was greatly overrated by public opinion. Pending the time when a decentralization of industry will offer wagework to farmers and when food consumption will balance production, a sounder solution than subsidy to augment farm income is to be found in a public conservation works program which will pay wages in return for work on those aspects of land reconstruction that cannot be undertaken by private capital.

The American people are not likely permanently to underwrite a system of subsidy for conservation practices that increase farm yields. They will, however, undoubtedly underwrite a conservation works program that will do necessary things that private land owners cannot do. A conservation works program will have the further advantage of giving additional income to the farmers who need it most, namely, those making an uphill struggle in denuded and devastated regions that most need rebuilding through conservation. These regions are the centers in which are congregated many of the small distressed marginal and subsistence farmers who received

relatively little or no help from the system of benefit payments. Of all our farm population, they are most in need of supplementary wage income.

The conservation works program, devoted to the "upstream engineering" phases of flood control, should be financed as an integral part of the flood and river development programs.

FINANCING THE LAND PURCHASE PROGRAM

The submarginal and forest land purchase program proposed in Chapter 7 is an exceptionally forcible example of the need and practicability of financing a substantial portion of the conservation enterprise as a capital investment. The bulk of this land can be developed as productive grazing and timberland, and as it is brought under care and management will yield increasing revenues from grazing permits, timber sales, hunting and fishing licenses, and the leasing of intermingled farming land. If the emphasis in the forest purchase program is placed on the acquisition of reasonably well-stocked young and middle-aged timber-lands, which can be steadily improved by thinning and selective cutting, and on the purchase of the redwoods and a substantial portion of the virgin Douglas fir forests of the Pacific Northwest, these properties will form a highly profitable public investment.

Obviously, it is hopeless to attempt to finance so large a purchase program from current income. And there is no necessity for doing so. The land could be paid for in special conservation bonds, redeemable in say forty years. All the receipts from these lands, less payments made to the States and counties in lieu of taxes, would go into a sinking fund to pay the interest on and retire the principal of these bonds. The financing of the entire project might well be a Federal undertaking, with provision for advancing funds to the States and local units of government including the soil conservation districts, for their share of the purchase program and for reimbursing the sink-

ing fund with a prescribed proportion of the receipts from these properties.

This entire transaction, so financed, would be essentially a transfer of title rather than a "cost." It would, to be sure, entail the subsequent cost of competent technical administration; but we may as well begin to face the fact that competent technical management of all land is a basic charge against the national income for maintaining the national patrimony. We do not expect railroads or steel mills to operate without skilled management, and it is unthinkable that from now on we shall let our natural resources continue on the road to destruction for lack of such management. And actually, on analysis, the "cost" of management fades away. Nobody—whether the owners, local industries, local government, or the nation as a whole—gets anything out of ruined, gutted land. If such land, managed, husbanded, restored, perpetually produces forage and timber, prevents floods and erosion, meets payrolls, and produces wealth to pay local and Federal taxes, the "cost" of management is a bookkeeping entry.

In reorganizing land ownership into a more rational pattern, it is not necessary, as pointed out elsewhere, to think exclusively in terms of the public purchase of low-grade or denuded land or of fragmented lands that need to be blocked up into larger ownerships for effective management. This is especially true in the western grazing lands, where both the Montana State grazing districts and the Farm Security Administration have shown the feasibility of cooperative land purchase, leasing and management by associations of users, provided they have credit facilities and will undertake competent technical management.

THE NEED FOR FOREST CREDIT

There remains another very large gap in our agricultural credit system in the lack of any provision for loans to finance

sustained yield forestry operations. The Forest Service, in cooperation with other agencies, has drafted and presented to Congress a bill to establish a forest credit bank in the Farm Credit Administration. This bank would make long-term loans to forest owners, including cooperatives, for organizing forests for permanent production. The transition from forest liquidation to forest management may involve financial readjustments, such as changes in manufacturing equipment and capacity, or investments such as roads, firebreaks, thinning and planting, and the purchase of land to round out sustained yield units. These credit facilities are needed not only by the large owners for large commercial enterprises but also by farm woodland owners in order to establish farm forestry cooperatives for the growing and manufacturing of timber products as an essential phase of a balanced rural economy. In all kinds of forest loans, there is an especial need for a strict control by the lending authority over forest management and timber cutting in order to protect the security of the loan by preventing any overcutting of the productive forest growing stock. It will require a generation or more of careful, expert management to bring our depleted forest resources up to full vitality and production; but this transitional period will afford a very large and profitable field for the investment of surplus, idle capital. Basically our forests are unrivaled in variety, vigor, and fecundity; and well-kept forests, managed by the principle of sustained yield, are investments of perennial stability and security.

THE NEED FOR CONTROLLED CREDIT

The time seems opportune to begin overhauling our entire farm credit system, public and private, to work toward better farm management as a basic security of all agricultural loans. The tragic history of natural resource depletion and soil deterioration throughout history and throughout the world,

emphatically proves that farmers as a class are not able to maintain the basic capital assets of the land without a great deal more technical assistance than they have received in the past. This is no discredit to farmers. The natural forces they deal with are so intricate and the advances of agricultural science have become so vast that the services of the all-round land management expert have become as essential to the farmer as the engineering expert is to industry. Such assistance has become vitally essential not only to protect the soil, the farmer, and the national security itself, but to protect the soundness of the entire agricultural credit system. As a measure of protection, the mortgage alone has proved to be inert and inept, and has ruined thousands of banks and tens of thousands of farmers. The reason is simple. Without the device of a competent management plan, as part of the loan contract, the farmer may invest his loan in soil-depleting and even in land-skinning practices, and bankrupt both himself and the bank in the process.

As pointed out elsewhere, the farm management plan as the basic security for agricultural loans has been highly and successfully developed by the Farm Security Administration and the Indian Service, and has reflected itself both in extraordinarily high loan repayments and in the prosperity of borrowers. It is sometimes loosely argued that farm loan contracts specifying certain standards of crop rotation or conservation practices are a form of regimentation of farmers. More accurately, the setting of such standards may be defined as good business sense on both sides. It is analogous to housing loans, where the loan is conditioned on detailed specifications and blueprints that are enforced through frequent inspection by the lender during the process of construction. A farm management plan worked out jointly by the farmer and the expert leaves abundant leeway for individual initiative and flexibility; the specifications are mainly technological, designed to maintain the capital assets intact.

To protect the public interest in our land resources, the

farmers in their basic capital, and agricultural credit in its basic security, our agricultural credit institutions, both public and private, should begin everywhere to adopt reasonable conservation standards in agricultural loans. Obviously, small private banks cannot employ technical staffs to assist farmers in carrying out loan contracts. However, groups of banks might club together to do so, or the government might enter into the loan contract to the point of furnishing the required advisory service. This would certainly be less of a government commitment than underwriting loans, as is sometimes done, and would greatly strengthen the country banks specializing in farm loans.

The use of public investment and of contractual credit to private borrowers in order to attain clearly defined national objectives in conservation is certain to become a powerful and acceptable method of stabilizing our agricultural economy. The use of long-range types of capital financing is more essential in the field of conservation than in any other human enterprise, for nature's time-span is long drawn out in comparison with the swift turnover of our day-to-day, short-range economic activities.

9

Our Lands Control Our Rivers

COLOSSAL and costly plans for flood control on many of our great river systems are being formulated by the War Department and the Bureau of Reclamation as a part of the program of post-war economic reconstruction. In a sense, the term "flood control" has almost become a misnomer; for, although these great flood-control projects have grown out of our desperate and tragic experience of destructive floods of ever-mounting frequency and fury, they are already beginning to look beyond mere flood control to the harnessing of our rivers as great creative resources. River control for "multiple use" has become the fashionable term—the multiple uses of flood control, navigation, irrigation, hydroelectric power, recreation, and wildlife preservation.

The impressive experience of the TVA has doubtless had much to do with this evolution of flood-control thinking from the negative stage of erecting bulwarks against calamity to the positive stage of recognizing a river as a great system of potentially beneficent power that can be harnessed for a multitude of human uses.

On the Tennessee and its tributaries, the TVA has almost completed its program of twenty-three dams and has acquired a number of others. These dams not merely conserve but regulate the waters of the great Tennessee River system. By weather stations throughout the watershed, the central regulating

office knows how much water is coming down the tributaries, either in wet weather or in dry; and by opening and closing the gates of different dams can trap or release water at will. As if pulling different stops on a mighty pipe-organ, the central control engineer can play upon this mighty system of dams in a way to convert formerly destructive floods into beneficent powers for human good. The electric power and the navigation facilities provided by this grandly conceived river development program will transform the entire economic life of the valley.

On all our great rivers, the engineers are applying the same large strategic concepts of unified control and multiple use. Daring and imaginative, they are lifting engineering to a magnitude of breadth and design never before conceived. Yet it is no derogation to this extraordinary advance in man's control over nature to point out that the evolution is not complete, and that the very magnitude of the new river control engineering demands that it will further enlarge its strategic concepts, lest it lose the great gains it has made.

The great remaining defect of our flood-control planning is that it stops at the river-banks and has as yet developed no significant means of controlling floods where they originate—on the land surface of the entire river drainage basin. The TVA, to be sure, has a conservation program, but a program that is wholly inadequate and entirely out of balance with its gigantic flood-control engineering works on the Tennessee River and its tributaries. Elsewhere, flood-control planning, done almost exclusively by engineers, makes no organized provision whatsoever for the measures of land-use control and minor upstream engineering to control the processes of destructive erosion and runoff that have unbalanced our river systems. Without a complete program of soil erosion control throughout the river drainage basins, the flood-control works on the main rivers are doomed to defeat and destruction. We

have not created the means either to plan, to administer, or to finance that indispensable half of a sound flood-control program. Under the Omnibus Flood Control Act of 1937, some authority was granted to the Department of Agriculture to perform this function; but with its present over-functionalized organization and its preoccupation with other aspects of agriculture at the expense of a truly national and global conservation program to stabilize our natural resources, it is not in a position to create and finance a grand national strategy of conservation and upstream engineering to match the great projects of downstream engineering that are being planned.

If a unified strategy of river and land control is to be applied to entire watersheds, there must be a unified planning and administrative agency with a mandate from Congress to do a whole job and nothing but a whole job.

So long as flood control was limited to the vain effort to contain raging rivers within artificial dikes, the lack of a land-control program was reflected only in the increasing destruction wrought by floods in river valleys. But now the imbalance has reached a critical stage. The destructive runoff and erosion that are destroying our soils and wrecking our rivers will also annihilate the billions of dollars of investment projected in dazzling but in the long run abortive engineering structures.

Needless to say, a critical analysis of the shortcomings of our present flood-control and conservation policies does not imply criticism of the many agencies that are doing valiant work on various segments of an enormously complicated enterprise. We are in the midst of a swift and vital evolution of thought in which the examination and reexamination of basic concepts is essential to prevent disastrous errors. It is impossible to apply a set of integrated ideas to the management of entire watersheds through a great multiplicity of confused and competing agencies that were not created for such a purpose and are incapable of achieving it.

HALF-MEASURES ARE NOT ENOUGH

Our flood-control programs in their present form are therefore only half-programs. They are an invitation to national disaster. The ever-increasing intensity and frequency of floods are due to the mismanagement of lands in the watersheds where the rain falls. Poor tillage practices on farm-lands, overgrazing and denudation of pastures and range-lands, and forest deterioration and destruction on a continental scale are the root of the flood problem. For on barren land denuded of its vegetative cover, rainfall runs swiftly over the surface instead of sinking into the soil; and as it rushes toward the stream channels, it picks up the unprotected soil particles and thus starts the fatal process of erosion. Our river channels are clogged and choked with this soil or silt. From our farm-lands alone, three billion tons of topsoil are being washed into our river channels every year.

Unless this far-flung process of erosion can be checked throughout the entire drainage basins of our river systems by an attack proportional in magnitude and vision to the projected engineering control program, the costly engineering works that are now envisaged will be doomed to early destruction by siltation. River-beds will continue to rise, as they are now rising, by the steady deposit of silt; dikes and levees will have to be built ever higher and higher, while the people and the cities in the valleys will live under the ever-increasing menace of their breaking; and the towering dams to be built for flood detention, irrigation, and electric power will become swiftly obsolescent as their reservoirs are filled with silt.

But the rapid liquidation of billions of dollars of investment will be only the beginning of the total disaster. Good dam sites are a comparative rarity in nature. The choice dam site is found where a river debouches from a wide deep basin, with large storage capacity, through a narrow gorge that can be

corked, like a bottle, by a narrow high dam. All the best dam sites will inevitably be preempted in the first wave of flood-control dams; and once they are ruined by siltation, there will be left in the main only a far inferior set of alternatives. The present flood-control program, lopsided and inadequate because it completely fails to come to grips with the land conservation problem, thus menaces one of our greatest national assets—the potential multiple powers of our rivers. The early destruction of all our best dam sites by siltation due to the erosion of our mismanaged lands would be an economic catastrophe of the first magnitude. Moreover, these imbalanced engineering programs will lull the people with a sense of false security and unjustified expectations, and thereby contribute to the national apathy which fatalistically tolerates the continued destruction of our basic agricultural capital and the disorganization of our rivers by soil erosion.

WATERSHED THINKING INSTEAD OF RIVER THINKING

In brief, our flood-control concepts have advanced to the stage where they deal with whole rivers as units. This is an enormous advance, but it is not enough. We need to deal in whole watersheds as units. We must replace river thinking with watershed thinking. And we must deal not only with unified ideas, but with types of organization that can put those ideas into effect.

The thesis here presented is not to do less river control, but to do more land control. It is not suggested that the initiation of the long-range program of engineering controls be postponed until we get our land resources in order. Our river systems have reached such a stage of destructive flooding that it has become a national imperative to use every possible device to curb them. But at best it will take from one to two generations to complete these gigantic enterprises. Far in advance of their completion, it will be possible, with bold energy and

imagination, to bring all our lands, in all our watersheds, under competent conservation management, and thus not only to insure the engineering works against swift depreciation, but to stabilize the natural resources on the abundance of which the success of full watershed development ultimately rests.

The Tennessee Valley Authority was created as an experiment in watershed thinking and watershed reconstruction. It was a substitute for the traditional, over-functionalized and fragmentary thinking and action of the older government departments. In the ten years of its existence, the TVA has progressed measurably toward the fulfilment of the purposes of its creators. It has made an enormous impression on the nation and the world. Already there is pressure from other regions for the creation of similar authorities, a pressure that will greatly increase as the era of post-war reconstruction gets under way. Consequently, it is an appropriate time to analyze the interrelated problem of flood control and conservation, and then to assess the experience of the TVA for the light it throws on the task of attaining complete watershed control.

The basic thesis here presented is that it is impossible to solve the flood-control problem without solving the land-control problem; that watershed control requires a complete, integrated, and articulated attack throughout the watershed; that the existing functional agencies of government, without a powerful mechanism of coordination, are separately and collectively incapable of such an attack; and that the minimum essential for complete watershed control and development is a unified administrative-planning-construction agency with full powers to do a full job. If we are to create means adequate to the end of complete watershed control, it is first necessary to grasp the nature of the watershed problem in its entirety, and then to deduce the nature of the required attack and the kind of mechanism that is capable of making such an attack.

THE BREAKDOWN OF WATERSHEDS

A great river system with its tributaries and its drainage basin running back to the divides that separate it from adjoining watersheds, is nature's system of discharging surplus rainfall into the sea so that it can resume its everlasting cycle to the clouds and back to earth. This drainage system, with its alluvial valleys bordering the main rivers, its intricate network of tributary rivers, creeks, rivulets, and springs, its plains and uplands, and its dissected ridges, foothills, and mountain masses, was sculptured out through eons of time by the action of running water. In the state of nature, a river system has been so engineered by natural forces that it has the capacity to perform its function smoothly and so stabilized that its function of land-sculpturing is long drawn out and imperceptible. Man's use of the earth, however, has so upset this natural stability and equilibrium that both land and rivers are in the process of violent disorganization. Our great watersheds are in the grip of catastrophic breakdown.

The process of land breakdown by devegetation and erosion is so insidious and obscure in its earlier stages that it escapes the casual observer. Moreover, its action on a given acre or farm, even when visible, is not impressive. It is only when one visualizes the destructive process going on over large regions and grasps its cumulative and collective effects that one realizes the immense dislocation and disruption of natural forces involved in soil erosion. Billions of tons of rain-water strike the earth with tremendous potential force. Nevertheless, if one understands the action of a single drop of rain, he can understand the essence of the process of erosion.

Raindrops falling on dense vegetation splinter into spray and are absorbed into the myriads of small pores that ramify through a rich, humus-laden soil. Raindrops falling on bare soil, on the contrary, first beat the surface into a compact layer,

so that all the pores are stopped by minute particles of soil that act like corks in bottles. The rain-water, unable to be absorbed by the soil, has no choice but to run over the surface; and as it runs, it picks up particles of soil, then gouges little rivulets, and finally, gaining volume and speed, begins to carve out gullies.

The faster water runs, the more soil it can carry; in fact, the amount of soil it carries increases at a geometrical ratio with its speed. Wind erosion is merely a variant of water erosion. Unless soil particles are bound down and held together by vegetation, even a moderate wind picks up the lighter particles, especially the rich organic material, and leaves behind the heavier particles of sand and gravel. That is why sand-dunes were forming in the Dustbowl in the great drought years, and why in many parts of the world there has been a steady encroachment of true deserts over great regions of agricultural land.

VEGETATION, THE CONTROLLER OF RUNOFF AND EROSION

The power of vegetation to control runoff and erosion is no mere abstract theory. It is supported by overwhelming experimental proof, based on precise measurement of erosion and runoff from small areas of land. Such measurements have been made in many regions of varying climate, soil, and vegetation; and wherever they have been made, they exhibit without exception a direct and controlling relation between density of vegetation and degree of erosion and runoff. Thus, in New York, during a period of precipitation totaling 9.47 inches extending over nineteen days in March, 88 percent of the rainfall was lost by surface runoff from a sloping potato field and over 1000 pounds of topsoil per acre were washed away. In a neighboring forest, on a much steeper slope, there was no soil wash whatever and 99½ percent of the rainfall was absorbed by the forest litter and soil.

In Wisconsin, on a 14-percent slope, over a three-year period, only 1.7 percent of the rainfall ran off a well-grassed meadow; whereas 20.6 percent ran off a cornfield. The respective soil losses are even more striking. The topsoil of the cornfield was being eroded at the rate of over 88 tons an acre each year, whereas the grass-land had an insignificant loss of only 38 pounds a year. At these differential rates, the cornfield would lose 7 inches of topsoil in eleven years, whereas the meadow would have lost an equal amount only at the end of 53,000 years.

Such examples, drawn from many different soil and climatic regions, could be multiplied indefinitely. They prove overwhelmingly and irrefutably that on forest- and range-land only a vigorous, dense, natural vegetation can control surface run-off and prevent destructive soil erosion, and that on farm-lands only level or contour cultivation and terracing, combined with strip-cropping, soil-building, and yearlong cover-crops—practices that form a substitute for dense natural vegetation—can put the rain-water into the soil where it belongs instead of letting it race over the surface and into the streams laden with silt.

It is only when we visualize the action of billions of tons of rain-water falling on millions of denuded acres that we can begin to understand why the land areas that constitute the great drainage basins of our rivers as well as the rivers themselves, are engulfed in a progressive breakdown. In the pre-Columbian wilderness of America, the virgin vegetation of primeval forests and prairies had forced water and soil to declare a truce and strike an equilibrium. In the conquest of a continent, we have destroyed or violently altered 90 percent of the original natural vegetation. Except for the fragment of virgin forests still left, only a small fraction of our whole land surface is tended and husbanded in a way to check the destructive power of rainfall and the processes of land disintegration. If we are to substitute watershed thinking for river think-

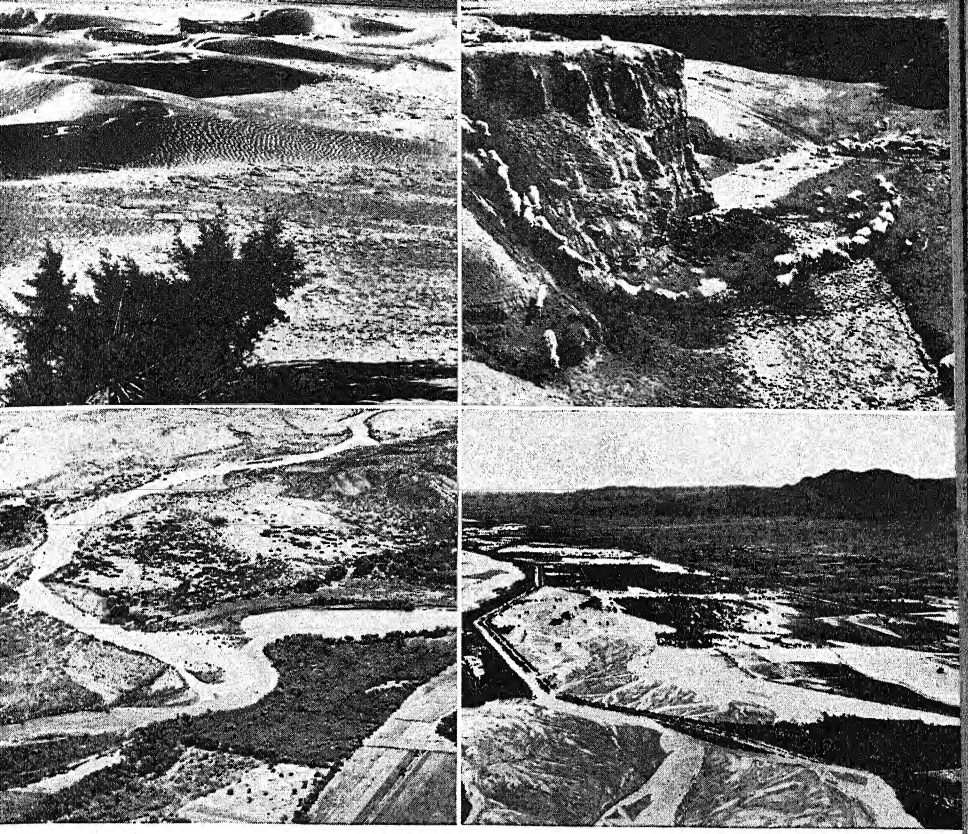

PLATE 13. Floods of ever-increasing frequency and intensity are due to the breakdown of whole watersheds through destructive land-use.

Upper left. In the "doomed valley of the Rio Grande," to take an acute example, long-continued over-grazing has led to land denudation.

Upper right. And to disastrous gullying.

Lower left. And choking the river channel with silt (note delta at mouth of tributary).

Lower right. And uncontrollable floods.

PLATE 14. Unless rapid runoff and erosion are checked throughout whole watersheds, elaborate and costly engineering works are doomed to rapid destruction by siltation.
Upper. Coolidge Dam in Arizona.
Lower. Conservation land use keeps floodwaters and silt out of the rivers.

ing, we must begin to grasp the immensity of the forces that have been unleashed to destroy our soils and disorganize our rivers. We are dealing in colossal aggregate processes at work on a continental scale over all our river systems.

In the light of these unleashed forces, we can begin to understand why in an incredibly short time almost 300 million acres, or about one-seventh of all our land, has been ruined or critically damaged, and almost 800 million acres is on the way to the same fate. We can understand why these damaged lands, aggregating more than half our entire land area, are making it more and more impossible to control floods in our great rivers. From our farm-lands alone, 3 billion tons of soil are being washed downstream every year. In a single dust-storm in 1934, 300 million tons of topsoil were carried from the Great Plains and diffused over continents and seas. The loss of soil fertility alone is staggering, for these 3 billion tons of topsoil carry with them 92 million tons of the main plantfood elements, together with the precious humus that contains them. These billions of tons of silt are piling up in our river channels, impeding navigation, steadily building up the river-beds, forcing the building of higher and higher dikes and more and greater flood-detention dams, and in short making the flood-control problem insoluble until erosion is everywhere brought to a virtual standstill.

THE WASTAGE OF OUR NATIONAL WATER SUPPLY

Erosion is only one horn of the dilemma of land breakdown. The other is swift runoff of surface water into the streams and its loss from the great underground storage reservoir. The underground reservoir is being depleted by the wastage of our national water supply by surface runoff. In many regions, the water table is steadily sinking. Springs, wells, creeks, and small rivers are drying up; and our river systems are more and more characterized by violently fluctuating high and low water

stages. We have upset the dynamic soil-plant-water equilibrium on a continental scale and replaced the harmonious household of nature with chaos.

If we look closely at the billion acres of erosion-damaged land in the United States, we find not only that it is shunting vast quantities of water into the streams instead of absorbing it into the soil, but also that over much of our land the violently escaping surface waters have carved a great new system of abnormal waterways known as gullies. There are over 200 million of these gullies in the United States. None of them were here at the advent of the white man. They are increasing with tremendous speed. They have gutted millions of acres beyond redemption. But here we are concerned primarily with their relation to floods. They are nature's way of shunting into our rivers the great surplus of surface waters which denuded, devegetated soils can no longer absorb and draw down into the underground water reservoir. Cutting first down into the richest and deepest soils, they are perfectly designed and engineered to carry great quantities of water at high speed. This high-velocity water, already laden with the rich topsoils and their food elements from denuded farms, forests, and grasslands, gains such speed that it is steadily carving the great system of gullies ever deeper, wider, and farther back from the plains into the foothills and mountains, and thus is able to accumulate a superload of silt to deposit in the main riverbeds. The whole process is thus double-acting and self-contradictory. The great rivers, by siltation, are steadily losing their water-carrying capacity while being called on to carry an ever-increasing load of surface water and silt.

RIVER CHANNELS CAN NO LONGER DO THEIR WORK

It is this balancing of mutually opposing and contradictory forces at work in our river basins that confronts the engineers with the mathematical impossibility of solving the flood-con-

trol and river-development problem by great downstream engineering works alone. It would, of course, be an exaggeration to say that soil erosion is the sole cause of the flood problem. There were great floods in the primeval wilderness of America. There would be great floods if the most intensive conservation measures were applied to all land surfaces. That is because periodically great quantities of rain, falling over large drainage basins, are beyond the capacity of the best-kept soil to absorb entirely into the underground reservoir. Nevertheless, the primeval rivers presented a very different picture from those same rivers today. They were designed by nature to carry peak loads and did carry peak loads, and their channels were stabilized. Erosion has radically altered the physical nature and the behavior of our rivers. The peak loads are increased by the increasing surface runoff and concentrated in shorter periods of time. The steady process of aggradation or building up of the river-bed is making it impossible to prevent destructive overflows into the densely inhabited river valleys. The higher the dikes are built, the more expensive it is to maintain them, and—more important—the less their frail barriers protect the lives and property of the dense populations living under their threatening shadow. As the dikes reveal their futility and their danger, great dams are thrown up to impound flood-water and silt, and these in turn are doomed to annihilation by the very forces they seek in vain to control.

There is only one real solution of the flood problem: namely, a total solution. Half-measures are futile. The downstream engineering program is an essential part of this total solution, but it is only a part. Yet it is easy to arouse the public enthusiasm for great engineering projects. Great dams are beautiful and impressive to behold. Their immediate wealth-producing utility is obvious and tangible. Like new postoffice buildings, they are universally popular and invite spirited regional competition. The conservation of land and water resources by upstream engineering lacks this popular glamor. It is unspectacu-

lar, laborious, and long drawn out. People grudge to spend money on the unobvious and the non-spectacular. In this universal apathy toward the geometrically increasing breakdown of our land resources, we have approached perilously near to adopting as a national motto "Billions for dams but almost nothing for soil conservation." And, in superimposing over our disintegrating land and water resources a dazzling array of mighty and costly flood-control structures, we are guilty, to quote the cowboy aphorism, of putting a hundred-dollar saddle on a ten-dollar horse. This does not make financial sense, economic sense, or social sense. We need now to lift our sights. We need watershed thinking instead of mere river thinking.

CONSERVATION, LIKE DAMS, IS CAPITAL INVESTMENT

The general apathy toward the destruction of our natural resources does not come so much from lack of awareness of the facts, as from a lack of understanding, primarily among officials, experts, legislators, and other leaders, of the fundamental economics of conservation. It is widely accepted that large investments in dams and other engineering structures are good investments in that they will amortize their cost both by the prevention of damage and by a greatly increased production of wealth. In the TVA, for example, the sale of electricity alone will pay off the entire investment in dams, navigation improvement, and hydroelectric plants and power lines in something like fifty years, without counting the new wealth that will be created by cheap electric power and by the development of navigation. Rightly, these projects are approached and financed from the standpoint of capital investment. To be sure, like any other productive enterprises, great river development projects involve the costs of planning and expert management. But these costs are absorbed by productive profits; and these profits, besides accruing to the private producers who reap the benefits of cheap electricity and river navigation, accrue also

to the public, first, in amortizing the original investment, and second, in the form of increased taxable wealth.

Precisely the same principles of investment finance and of planning and management costs apply to the national conservation enterprise. The production of our agricultural lands can, in the long run, be approximately doubled by the amazingly effective and beautiful technologies of erosion control and soil conservation worked out and already applied on a large scale by the Soil Conservation Service. The productivity of our western grass-lands, both in private and in public ownership, can also be approximately doubled through grazing management, range revegetation, and erosion-control works. Our forest productivity can be at least quadrupled, both in quantity and in quality, by competent forest management. Consequently, the costs of providing expert management for our entire land area, whether the cost is met wholly by the government or in part by the government and in part by the land owners, will be recouped many times over by the increase in the national wealth.

FINANCING UPSTREAM ENGINEERING

But in addition to providing a permanent expert management service, there is also the need to finance a very large program of upstream engineering works to reverse the process of land breakdown where it has become acute. Multitudes of small tributary streams must be equipped with silt detention dams to keep silt out of the main rivers during the long-drawn-out process of land reconstruction. Our 200 million man-made gullies must be stopped from further spreading and dammed to trap silt and fill back up to their natural level. These 200 million gullies, by being developed as silt traps, will keep billions of tons of silt out of our river channels and great and small reservoirs during the period required to effectuate a nation-wide program of conservative land management to halt

erosion at its source. The natural channels of tributary streams must be reestablished and their banks safeguarded. Great areas of denuded forest-lands or severely eroded farm-lands must be reforested. Great systems of forest firebreaks and forest roads must be created.

How can these and other such works be financed? In part, they can be financed by making long-term credit available to private land owners to spread out the cost of the more expensive parts of land reconstruction over a period of years. But over great areas of badly damaged private land and also over the public lands, government must assume a substantial share of the cost if the work is to be done at all. The bulk of the public cost of the conservation enterprise, like the cost of river engineering, should be met by capital financing, and should be included in the cost estimates of all flood-control projects. Planning and administration costs can be met out of current appropriations; but financing the river-control and land-conservation program as a whole by current appropriations is entirely beyond our financial capacity. Deficit financing through overdrafts on the Treasury under the guise of "appropriations" that are actually borrowings confuses the entire economics of these great productive enterprises, and makes them the football of political assaults by those who confuse debt with investment.

The true investment costs of both downstream and upstream engineering should be financed by bond issues to be amortized by the sale of electric power and by the future taxation of increased wealth. If a seventy-five-year amortization period were adopted for these investments, the sale of electric power would amortize a substantial part of the cost of downstream and upstream engineering throughout the watershed. Only actual experience can determine the rate at which the initial costs can be met, and the rate will vary as between different watersheds. But if full watershed development greatly increases our national productive capital and our national income, we must

approach the enterprise with the same boldness, vision, and imagination with which our ancestors cleared the virgin wilderness, built our transcontinental railroads, and created our elaborate industrial system.

AN EXAMPLE OF REGIONAL SUICIDE

In shifting our thinking from river control to watershed control, we can best grasp the kind of job that has to be done by taking a specific watershed as an example; and after analyzing the nature of the task, and the agencies already at work on segments of it, we can better visualize the kind of streamlined administrative agency required to do a complete watershed job.

The Rio Grande watershed in New Mexico is illuminating for several reasons. Nowhere on this continent and almost nowhere in the world is there to be found such a dramatic and disastrous example of the breakdown of a whole watershed and its river system. The well-known geographer, J. Russell Smith, has appropriately called the Rio Grande watershed "the doomed valley, an example of regional suicide." Yet in this valley, government flood-control engineers are at work on flood-control and river-development plans that are tentatively estimated to cost upward of $100,000,000 in engineering works, with no corresponding program on the part of the numerous Federal and State conservation and agricultural agencies in the region for a comprehensive attack on the fatal erosion that is dooming this valley and its people.

HISTORIC ADVANCE OF EROSION IN RIO GRANDE VALLEY

The Rio Grande River, rising in a semicircle of high mountains in southern Colorado, flows southerly through New Mexico and thence across a corner of Texas, and thereafter forms the boundary between Texas and Mexico. In its course

through northern and central New Mexico, it flows through fertile valley lands that have been irrigated for three centuries by descendants of the Spanish conquerors and their Mexican followers and for eight or ten centuries by Pueblo Indians. Hemming this valley in are high mountain ranges in the north which taper off into broken lower mountains, hills, mesas, and plateaus farther south. All this mountain and upland country is drained by numerous tributaries. The high mountains are covered by primeval forests, the foothills by stunted pine and cedar, while the vast extent of plateaus, mesas, and plains was originally covered by a dense growth of grass and other native vegetation.

The conquering Spaniards learned irrigation farming from the Pueblo Indians and supplemented it by the grazing of cattle, sheep, and horses, which had been unknown to the Indians. While there are some historical evidences of overgrazing in the Spanish period, it did not begin to occur on a dangerous scale until well after our conquest of New Mexico in the Mexican War. After the Civil War, as the railheads were pushed westward, commercial cattle and sheep raising grew in the West by great strides. New Mexico was no exception. Commercial livestock, developed by the incoming Anglo-Americans, often with English capital, rapidly preempted the great bulk of the range-lands, pressing back the Spanish-American and Indian farmers, who also owned livestock, onto an ever-shrinking land base.

Two factors led the livestock growers to heavily overstock the range-lands. The native grasses and other vegetation were abundant and vigorous; and no one knew, in that day, that in a semi-arid climate vegetation at best achieves a very precarious foothold. It can easily be depleted or completely annihilated by overgrazing; and once the vegetative cover is severely thinned out, dessication and erosion of the soil are usually rapid and acute. Another thing that encouraged overgrazing was the fact that the bulk of the range-lands (including

the forests of the mountains) were in government ownership, though wholly unadministered and unmanaged. There was consequently a wild scramble for the use of these free lands, with many a feud and range war.

Even when at the turn of the century, the forests of the mountains were set aside as National Forests, to be scientifically administered for timber production, range management, and watershed protection, widespread overgrazing, denudation, and erosion were already well advanced; and when a whole generation later, the Taylor Grazing Act of 1934 tardily established the technical administration of the open grasslands of the public domain, overgrazing on these lands in New Mexico and elsewhere throughout the West had carried erosion to disastrous lengths. Meantime, the Spanish-Americans and Indians, crowded back onto their own land grants and what little of the public domain they could snatch from the large graziers, set up a process of destructive erosion in the main valley itself and the immediately adjoining bench-lands.

THE WAR BETWEEN HIGHLAND AND LOWLAND

In this war between highland and lowland, between the big graziers of the plateaus and mountains and the small subsistence farmers and graziers in the irrigated farms of the valley, the river and valley were inevitably doomed to defeat. Torrential summer rains run swiftly off the denuded watersheds, causing "flash-floods" in the tributaries and the river itself. From the denuded highlands, from the great and growing network of gullies that are devouring the land, and from the fertile bottom-lands of the tributaries huge quantities of silt have been and continue to be swept into the Rio Grande. Its channel is filled almost to the top of the banks, and in its more level stretches its bed is building up almost 4 inches a year. So high is the river-bed that in many places it is already becoming impossible to drain the irrigated land. The ground water level is

constantly rising toward the surface and large areas of formerly cultivated lands have become waterlogged swamps. Silt is filling up the great Elephant Butte Reservoir at the rate of 18,000 acre-feet a year—enough silt to cover 18,000 acres to the depth of a foot. Since it was built in 1915, it has lost approximately 450,000 acre-feet of water-storage capacity. In this dam and the 155,000-acre irrigation project it waters in southern New Mexico and Texas, the government has invested $25,000,000, which it expects in time to recover from the water users. But siltation, if unchecked, will in seventy-five years reduce the capacity of the reservoir to the mean annual draft, which means that in drought years, which are frequent, there will be no water for irrigation. Siltation, if continued, will bankrupt this project. Considering that the Pueblo Indians have successfully farmed irrigated lands in the Rio Grande Valley for probably eight centuries, it would be fantastic economics and public policy to permit an agricultural community of almost 30,000 people to be liquidated in a century or less.

The tentative engineering plans of the Bureau of Reclamation call for a large flood-control and hydroelectric dam on the upper river, silt detention dams at the mouths of three of the worst tributaries, other flood-control works, the diversion of surplus water from the San Juan to the Rio Grande, and the development of substantial additional irrigation projects. If flood control is to begin and end with the river itself, these plans, while giving a temporary amelioration, would be merely a stay of execution to the "doomed valley." Like all other engineering plans, it suffers the fatal defect of failing to trace the river sickness to its real source, the land sickness. As a long-range investment, $100,000,000 spent in this great development would not be excessive, provided it were coupled with the substantial additional investment required to check and reverse the disastrous overgrazing and erosion prevalent throughout the watershed. Without a complete conservation and land reconstruction program, not only the valley but the

expensive engineering system is doomed. At the present rate of land destruction, the Middle Rio Grande Valley will be virtually uninhabitable in three or four generations.

THE FIRST STEP: RESTORE NATURAL VEGETATION

What then needs to be done for land reconstruction? First and foremost, the heavy overgrazing must be ended, and quickly at that. A reduction program extending over ten years would not be overdrastic. For many years the range carried double the number of livestock it was capable of carrying. For the whole watershed of the Middle Valley, the depletion of vegetation averages 35 percent of a normally complete ground cover; over extensive critical areas the depletion is 75 percent or more. The range is still overstocked by 75 percent, and this overstocking exists despite the fact that the bulk of the land is in Federal ownership. For many years the Forest Service has been reducing livestock in the National Forests, against strong opposition; but the National Forests are still overgrazed partly because reductions tend to be offset through the replacement of forage plants by the dense young forest growth following forest-fire protection. The Grazing Districts, only a few years under administration, are heavily overstocked. Likewise most of the Indian lands and the community land grants of the Spanish-American villages are overgrazed, and overgrazing is widely prevalent on private lands. Fortunately, a large portion of the private lands have been recently embraced in the newly created soil conservation districts under the State soil conservation district act of 1937, under which the Soil Conservation Service cooperates with the land owners in the districts in promoting good farm and range management.

Stock reduction in the National Forests and the Federal Grazing Districts is hampered by reason of the existing policy of granting preferential grazing rights on the part of large owners at the expense of small owners. Two percent of the

livestock graziers control over 50 percent of the range, public and private, in the Rio Grande Valley. In its broad social aspects, this monopoly is undemocratic and alien to our long tradition of equitable division of the public lands. It is particularly undemocratic in view of the fact that the rural Indians and Spanish-Americans, who constitute 96 percent of the whole rural population of the Middle Valley, are forced to live at a peasant standard of living far below the average of our general farm population. These large vested interests in the public range-lands, fostered by the government itself, have an immediate political consequence. It is largely the political strength of the large livestock owners that has made reduction to carrying capacity difficult. Quite apart from the question of democracy and fairness in allocating use rights on the public lands, there are pressing practical reasons for a combined program of livestock reduction and range reallocation. The first is to protect the land and vegetation from further deterioration. A second is to protect the heavy proposed investments in river control. A third is to protect the valuable irrigated bottomlands while undertaking to develop them to full productivity. And finally only such a program will relieve the Federal and State governments from carrying a chronic and increasing relief burden among the small farmers and rural laborers living at a submarginal level.

Stock reduction to the point of permitting natural reseeding and recovery of range vegetation will provide in a relatively few years a dense enough vegetative cover to control erosion and surface runoff over large areas that have not yet reached the critical stage of erosion and denudation. Moreover, it will greatly increase the ultimate carrying capacity of the range by bringing back the native grasses as the predominant vegetation and reestablishing a dense vigorous stand with high productivity. Livestock reduction and range recuperation are absolutely essential to saving the livestock industry itself, which is now digging its grave with its own teeth.

THE SECOND STEP: UPSTREAM ENGINEERING

A second major part of the needed land reconstruction program is the minor engineering works required to stop erosion and retard surface runoff on the tributary watersheds and land surfaces. In the semi-arid range country, the Soil Conservation Service has already had ten years' successful experience with such devices. They include dams and weirs to stop and fill up the large gullies, some of which are 40 or 50 feet deep and several hundred feet wide; check-dams in small gullies; water spreader dikes to lift water out of gullies and spread it over valley lands to promote vegetation; contour water catchment furrows on sloping grass-lands and terraces on steeper lands; reseeding of denuded lands; fencing of ranges and development of water to control distribution of livestock; and similar measures. These upstream engineering works collectively perform two functions: they halt and reverse erosion in its most advanced and destructive form, and they greatly speed up the process of revegetation.

THE COSTS OF UPSTREAM ENGINEERING

What will such a program cost, and how will the costs compare with the tangible, calculable benefits? The Soil Conservation Service has made a careful engineering study and plan for the Rio Puerco, the largest and most destructive tributary of the Rio Grande in the Middle Valley. Through the 150 miles of its course, it drains 3,900,000 acres. The Puerco has carved itself into a wide deep gully, ranging in depth from 10 to 40 feet and in width from 350 to 600 feet, and together with its tributary gullies, it discharges an enormous amount of floodwater and silt into the Rio Grande and the Elephant Butte Reservoir. To control the main stream itself, the Soil Conservation Service proposes to build six dams and sixty-five

spreading weirs, designed over a period of years to completely fill the great Puerco gully with silt, of which it will hold 235,000 acre-feet that would otherwise go into Elephant Butte. These works, combined with an extensive program of erosion-control works on about 250,000 acres of critically denuded land, would cost $10,500,000, including the costs of range management.

Over against this investment are to be set the measurable, calculable benefits, which were carefully analyzed by the conservation experts. They include such things as the value of increased forage and livestock, the value of bottom-lands that will be saved from gullying, the saving of irrigation water, the saving in damages to railroads, highways, and bridges, and the prevention of flood and silt damage to the Rio Grande Conservancy District. The total of these benefits will average slightly under $1,000,000 a year; so that over a period of years, the costs would be inconsequential compared with the greatly increased production of tangible wealth.

This carefully calculated program affords a rough means of calculating the cost of upstream engineering for the entire Middle Rio Grande watershed. The Rio Puerco drains somewhat less than a fourth of the whole area. At this rate the upstream engineering program would cost upward of $40,000,000. If spread over twelve or fifteen years, at the rate of about $3,000,000 a year, it would cost less than double the annual pre-war Federal relief expenditure of $1,800,000; and would afford creative, wealth-producing employment for the surplus valley population. Not only in the Rio Grande valley, but throughout the United States, systematically planned upstream engineering works for land reconstruction and flood control, at good wages, should be substituted for miscellaneous and relatively unimportant relief work projects and for outright subsidies in the way of agricultural "benefit payments" as a means to increase the income of distressed farmers. As in the Rio Grande valley, so elsewhere, it will be found that the

great bulk of distressed farmers and unemployed agricultural workers are concentrated in regions where the economic resources have been wrecked by erosion and deforestation. Engineering works in the main valleys will only partially solve this problem, since neither reclamation projects nor industrialization can in the long run absorb a large surplus of labor created by the destruction of natural resources. Managing and reconstructing our land resources for full production and full employment is as vital to national prosperity as full industrial production and employment. Only the combination of the two can create the real wealth of abundant goods; and when this combination is fully effective, it will be found that we have no surplus of land and no surplus of agricultural and forest resources.

The Rio Grande watershed, used here merely as an illustrative example of the close interrelation between river control and land control, is typical of much of the great semi-arid region west of the one hundredth meridian of longitude. In the humid regions of the Middle West, the East, and the South, the specific problems involved in controlling erosion and runoff differ, of course, from those of the semi-arid West. But the underlying interrelations between the land and the river are precisely the same; virtually every watershed in the United States exhibits the evil combination of erosion, rapid runoff, and siltation of river-beds. In humid regions, the primary emphasis shifts from control measures on natural range-lands to control measures on cultivated and pastured farm-lands and in forests. Despite these variations in emphasis and technology, the basic principle here set forth—that river control without land control is a contradiction in terms—is universally applicable. The motto of flood control should be: Keep the silt on the land and the water in the ground.

Thus far we have discussed merely the main initial aspects of land reconstruction aimed at stabilizing land and water resources and reversing the trend of deterioration and destruc-

tion. It remains to deal with two other aspects: the policy-making and planning job involved in upstream engineering, and the long-range technical administration and management of land resources. Historically, in the Rio Grande Valley as elsewhere throughout the United States, the existing functional units of government have shown that they are not properly organized, grouped, and directed to perform these broad functions effectively. A whole watershed, being as it is an interacting system of natural forces, requires unified planning and administration. The next chapter, drawing on our accumulated experience to date, will attempt to analyze the type of watershed administration required to do the unified, total, and integrated job of land and water control without which the colossal engineering plans now being projected for river control will be doomed to defeat and annihilation and our civilization will be sapped and undermined in its basic foundations.

10

Integral Watershed Development

TVA has given mankind the glimpse of a new and potent control over nature, the vision of a more beneficent, more fruitful habitat for civilization. No other engineering work in history has aroused such world-wide interest as TVA's bold and daring conquest of a great river system and the capture and taming of its immense energies for human welfare. No modern experiment in government has more effectively used the surgeon's knife on the disease of centralized, slow-moving bureaucracy. And no other public agency has been more thoroughly imbued with the concept of developing our economic resources not only democratically for the benefit of all the people, but ethically and permanently as a heritage held in trust for future generations.

TVA was created as an experiment in the unified planning and development of a great river valley and of its water and land resources. As a laboratory of social creativity and public administration, it has been operating for eleven years. Has it any lessons for other river valleys and for the art of government? More specifically, what basic principles of planning, management, and public administration emerge from the TVA experiment that can be drawn on for the conservation and full development of the natural resources of this continent?

BASIC CONCEPTS OF WATERSHED DEVELOPMENT

We can disentangle two basic concepts in the TVA experiment. One is the concept of the government corporation clothed by Congress with very large powers of decision and action. It was a conscious departure from the traditional departmentalized, bureaucratic form of government, with its ascending hierarchy of officialdom who must be consulted and frequently placated and often interminably negotiated with on both major and minor matters. The TVA corporation came as near as the law would allow to the freedom of a private corporation. Moreover, it was moved out of Washington into the valley where its business lay and its dreams were to take form. This was much more than a mere geographical translation. In settling down to its job with the waters and the lands and the people of the Tennessee Valley, the TVA had enough power and freedom to clip the apron-strings that bind most other governmental field agencies to Mother Washington.

The corporate form of public administration is a relatively new departure in government. In England and in America it has already shown some striking and promising results. Yet its corporate form is not the most fundamental characteristic of the TVA. The other basic concept embodied in the TVA is the concept of an integrated, unified attack on the totality of the problem confronting it—namely, the full development and utilization of the natural resources of an entire river valley. As will be brought out, this basic concept has not been fully achieved by the TVA, partly because of defects in the basic legislation. Nevertheless, the concept itself is absolutely sound since it is dictated by the very nature of the problem confronting mankind in the use of natural resources.

A river system and its entire land drainage basin is a natural unit, an indivisible whole. In a state of nature, undisturbed by man's fatal predisposition to ravage the earth, this indivisible

whole constitutes a dynamic equilibrium, in which the soils, waters, and vegetation work together to achieve a perpetual, though moving, harmony. Man's use of the earth has violently disrupted this harmony. Widespread deforestation, overgrazing of pastures and natural grass-lands, and destructive methods of soil tillage have led to a cataclysmic disturbance of nature's equilibrium. This disturbance extends over great land masses and entire river systems, resulting in violent soil erosion, the swift runoff of rain-water, the depletion of the great underground water reservoir, violent and frequent floods, and the sedimentation of river channels and reservoirs. The cumulative effects of this violent breach of nature's harmony may be summed up briefly as the progressive destruction of the earth's soils, the wastage of a large proportion of the rainfall, and the turning of our rivers into wild furies which are more and more getting beyond the power of man to tame.

The purpose of unified river "development" is, first of all, to reverse this process of destructive disharmony and to recreate a system of internal balance among the natural forces at work. But this is no mere "return to nature." It involves the creation of a new man-made balance, superior for human use to the primeval natural balance, in that the rivers can be made to yield up immense energies to do man's work and the soils can be made far more fruitful, with man's artificial plant complexes, than they were in the natural state. Equally important as the restoration of a balance in these natural forces is the balanced use of these resources; for obviously it would be nothing short of regional suicide to develop huge power resources for an exploitative economy that would wreck the natural resources on which alone a permanent, democratic economy can be built.

Any agency that is to cope successfully with watershed reconstruction must be able to deal in terms of the over-all strategy of reestablishing a harmonious balance among the interrelated and interacting forces of soils, vegetation, and water through-

out the length and breadth of the entire drainage basin, from the majestic onward rolling current of the great river itself to raindrops beating on a stripped woodland or an eroding pasture far back in the mountains. Its job and its goal is nothing less than the scientific management of the land from the river's edge to the farthest divide. In this quest are involved an enormous range of engineering, land-use, and social techniques, which nevertheless must be fitted together into an orderly and rational pattern. Consequently, whatever may be the form and structure of a watershed "authority," it must have the will, the intellectual competence, the social outlook, and the command of the necessary freedom and power to define and work toward these goals. The power of integral planning and action is the *sine qua non* of whatever agency is set up to deal with watershed reconstruction.

Now, there are doubtless many possible modes and forms of integrated administrative attack on the watershed problem; but since TVA was established for the precise purpose of such an attack and has gone far in demonstrating the soundness of this basic concept, it seems wise to build on the TVA experience rather than either to revert to the old, piecemeal efforts at flood control or to build an entirely new watershed administrative agency, while ignoring the lessons of TVA. Let us, therefore, look at TVA as it is, against the background of its total problem, to determine what its main strengths and weaknesses are.

PLANNING AND ACTION UNITED IN TVA

In creating the TVA, Congress set up a streamlined modern corporation, freed from leading-strings centered in Washington. As in a modern business corporation, planning and action are fused together. With ample financial resources, including bond issues and receipts from the sale of electricity, and with a merit-system personnel free from the Civil Service Com-

mission, the TVA is able to make large decisions and execute enormous work projects swiftly and without red tape. Its impressive achievements, in eleven years, in harnessing a great river and in stimulating the economic rehabilitation of a great valley, are too well known to need rehearsal. Briefly, it exercises the broad functions of unified planning in cooperation with numerous Federal, State, and local agencies, of developing large-scale construction and operational projects for flood control, navigation, and hydroelectric power, of producing and distributing electricity, of promoting scientific agriculture and forestry, of stimulating new industries, and of conducting a wide range of research pertinent to these farflung activities. TVA's outstanding and spectacular achievement is its vast system of interlocking dams, which impound floods in more than a score of great man-made lakes and transmute them into electricity.

Undoubtedly, the gathering together of directive, coordinating, and executive activities in one agency, with a broad mandate from Congress and with freedom of action, is, on the record of achievement to date, convincing proof that we can, if we will, conserve and develop our resources for the benefit of all our people and bring an end to our long pioneering exploitative waste.

It was suggested shortly after our entry into the war [1] that authorities of the TVA type be quickly organized throughout the United States to coordinate civilian war production and to plan and execute a great program for the full development of all our resources after the war. This program would include not merely flood control, hydroelectric development, conservation, and inland navigation, but general industrial development under a balanced program of decentralization, stability, and full use of regional resources. Hansen and Perloff estimate

[1] ALVIN H. HANSEN and HARVEY S. PERLOFF, *Regional Resources Development*, Planning Pamphlet No. 16, October, 1942; National Planning Association, Washington, D. C.

that about $2,000,000,000 a year should be invested in this great development work over a whole generation. They further suggest that an agency be set up directly under the President to coordinate the activities of these regional authorities.

More recently, the movement for flood control, river development, and the creation of new valley authorities has received a great impetus as a part of our national program of post-war reconstruction. The War Department and the Reclamation Service are making plans for flood control, navigation, and land reclamation involving investments of several billion dollars. Valley authorities for the Missouri and other rivers are being projected.The Hansen-Perloff program may turn into a practical reality in the next few years.

OBSTACLES TO SPREAD OF VALLEY AUTHORITIES

Yet, despite the brilliancy of the TVA achievement and its world renown, there are serious obstacles to transplanting the same or a similar type of unified watershed authority to other river systems in America. One pervasive obstacle is the very brilliancy of the achievement. It requires will and energy to surmount the apathy bred by the long domination of our lazy and comfortably chaotic laissez-faire social philosophy and to rise to the heroic challenge of the scientific conquest of a continent. The present generation is lost between the old pioneers and the new; it needs to recapture the courage of the earlier and to grasp the vision of the latest adventurers toward new frontiers. And beyond apathy is the important fact that the full development and conservation of natural resources for the benefit of all the people encounters the entrenched opposition of monopoly and exploitation.

But here we are concerned with obstacles of a more concrete nature. One is the strength of the opposition against the creation of straight-line Federal regional agencies to deal with

problems which, whatever their national implications, are of the utmost concern to local people and to local institutions of government. Another obstacle is that the original TVA statute does not resolve the potential conflict between regional authorities and the older executive departments which also exercise important functions in watershed development. Finally, a serious technical weakness of TVA primarily, inherent in the basic statute itself, is the failure to develop a thoroughgoing watershed conservation program to prevent ruinous soil erosion and deforestation.

THE STATES' RIGHTS ISSUE

Undoubtedly, the Federal government, under the Constitution, has both the authority and the duty to regulate and protect navigable streams. Moreover, under the expanding concepts of modern law relating to what may be defined as the "indivisibility of social process," this Federal power over navigable streams embraces a multitude of functions necessary to attain the constitutional end, such as the sale of electricity and the prevention of deforestation. Theoretically and legalistically, therefore, the exercise of these functions is not an encroachment on local self-government. Nevertheless, in actual practice, such a great increase in the scope of Federal activity vitally affects the lives and daily welfare of all the people coming within its reach. The issue of centralism *versus* localism—one of the most important governmental issues in the modern world—is likely to becloud the creation of competent agencies for regional development until it is resolved on sound principles of democratic government. Here again there is no one formula. It will require healthy experimentation and invention to achieve a sound fusion of central and local authority which will recognize both the need for integral planning and administration and the insistence on a popular voice in vital decisions.

The experimental TVA legislation did not fully resolve this paradox. The basic statute gives the State and local agencies no defined share in the enterprise in its entirety, except a preference right to the purchase of electricity. The statute merely authorized the Authority to cooperate with State, local, institutional, and cooperative agencies in making surveys and plans; there is no mandate for such cooperation, still less is there provision for any advisory or deciding voice by any of these agencies.

In actual practice the TVA has gone very far in developing cooperative procedures, both in planning and in many phases of executing its projects, with State, local, and cooperative agencies, as well as with functional Federal agencies. In these cooperative undertakings, it has made use of contracts defining the rights and duties of both parties, and has stimulated many agencies to shoulder important jobs. Thus, for example, most of its agricultural work is carried out by the State and county extension agencies, with financial assistance from the Authority. In thus pursuing the democratic but somewhat slower way of participative action, the TVA has evaded the temptation to bureaucratic bigness, authoritarianism, and domination, and has stimulated and energized the people and institutions of the Valley to the point, indeed, where its success as an experiment in creative democracy is at least as significant as its technological achievements.

Nevertheless, this democratic practice, as distinguished from the legal formulas in which the basic act is clothed, does not get to the heart of the issue of centralization *versus* localism. For the cooperation with the local instrumentalities of government is merely permissive and not mandatory, and even this permissive authority is defined only in the most general terms. Under these terms, whether the Authority will enter into cooperative activities at all, in what fields, and under what terms depends on the good will of the Board of Directors, and co-

operation may be extended, revoked, or restricted at will. This basic legal defect is not altered by the fact that thus far the Authority has elected to follow the cooperative way; for a different Board, with different ideas of administration, might build an entirely self-contained and exclusive planning and administrative agency.

In fairness to the adherents of localism and home rule, then, it cannot be said that, in its legal structure, TVA represents what is commonly understood by decentralized government, i. e., government of, for, and by local people. Rather it is a geographical localization of Federal government, chiefly distinguished by the fact that it has been freed of long-distance wetnursing by departments in Washington. But the fact remains that legally the responsibility and accountability of TVA is upward to the Congress and the President and not downward to the States and the people.

In the light of the heartening success of TVA in democratizing its methods, it may seem ungracious to raise at all a question that may seem purely theoretical. This question, however, is raised not by way of criticism but in pursuit of an answer to the problem, What modifications of the TVA idea are needed to make integral authorities acceptable in all our great river valleys, in a way to give the valley peoples a clearly defined voice without hamstringing the unique powers that are required to do a competent job?

LOCAL PARTICIPATION IN VALLEY AUTHORITIES

We are not here concerned with the brand of "States Rights" which has frequently been invoked throughout our history as a means to block Federal action on matters of vital national interest and as a cloak for do-nothingism, drift, and reaction on the part of local politicians and vested interests. One of America's most urgent political needs is to work out formulas

of strong Federal leadership accompanied by strong and revivified State and local participation. The obsolete States Rights impasse must be replaced by a dynamic and effective pattern of partnership, in which State responsibilities in national programs must be recognized and discharged. Only such a partnership can head off the trend toward Federal centralization, which is an almost world-wide phenomenon growing fundamentally out of the disintegration and apathy of local institutions. Instead of surrendering democratic rights to a managerial elite, in industry and in government, we need competent forms of decentralization through which ordinary men can recapture and again exercise the civic virtues.

In such notable and successful experiments as the State social security laws, the standard soil conservation district laws, and the labor relations act, we have made brilliant achievements in this type of national partnership under strong Federal leadership, with effective, responsible local action. These laws are marked by clear, precise, detailed definitions of rights and responsibilities. There is no one formula, however, by which the partnership idea can be extended. The formula will depend entirely on the field of action involved and the relative interests and responsibilities of the different levels of government.

Quite obviously, in river development programs the Federal government has a major interest and responsibility. The Constitution gives it jurisdiction over navigable streams, and by implication over their tributaries and indeed over the condition of the entire land surface of the drainage basin insofar as rapid runoff and erosion may affect navigable streams. Equally obviously, the States and local communities have a major interest in the manner of development of these resources and in the distribution of their benefits, since they are intimately related to the social and economic welfare of the entire community. In fact, as one analyzes relative interests and responsibilities, any cut and dried division becomes very

shadowy, since the national and the local welfare are inextricably fused together in the delicately and widely interacting structure of modern society.

LOCAL REPRESENTATION IN WATERSHED AUTHORITIES

Now, there are many ways in which formal local participation in the plans and decisions of a watershed authority could be arranged without impairing the basic integrative function of the authority. Boards of directors of corporations are elected by the stockholders. The boards of cooperatives are elected by the members. So far as maintaining their essential integrative functions is concerned, we can conceive of competent boards of directors for watershed authorities being elected by all the citizens of the given watershed. Or they could be elected by organized functional groups, such as agriculture, labor, industry, and consumers. It seems likely, however, for the present at least, while watershed authorities are in the experimental stage, that boards of directors of the authorities will be appointed rather than elected. But even so, the States in a given valley could be represented on the board by being given the privilege to appoint, or at least to nominate subject to the concurrence of the Federal government, a part of the board members. Because of the paramount constitutional authority of the Federal government over navigable streams, it would be fair to give the States no more than minority representation on the board of directors, while augmenting their participation in the whole enterprise in other ways.

One of the most important ways to increase local participation in the whole enterprise is at the level of planning. It is here that the valley people have the greatest interests at stake. For the planning and policy decisions of the Authority will profoundly influence, for generations to come, the daily lives and welfare of all the people and all the communities of a given river system. The fair distribution of electricity, the develop-

ment and decentralization of industry, the allocation of natural resources, the use of water for navigation, reclamation, recreation, and wildlife, the extent and efficacy of soil and forest conservation programs, the broad trends of agricultural and industrial policy, the problems of interregional competition and cooperation—these are only examples of the vital questions on which decisions must be taken as the over-all regional planning proceeds. It is no exaggeration to say that the production, control, and distribution of hydroelectric energy alone is one of the most important of all clues to the democratization and decentralization of our industrial economy and to the full development of regional resources. In all these decisions all the people have a vital interest and should have an important voice —a voice recognized and institutionalized in the law itself.

A WATERSHED CONGRESS

One way to assure popular participation in these plans and decisions would be to establish a Watershed Congress, composed of representatives of local units of government (counties, municipalities, organized Indian tribes, and soil conservation districts, which because of their large numbers would have to use joint representation) and representatives of functional groups, such as agriculture, labor, industry, and consumers. This combination of geographical and functional representation would give the "average man" a double voice in watershed planning—first, as a citizen of a local community whose claims should be heard, and, second, as a member of an occupational group whose interests should be protected.

Would such a popular advisory body be a drag on the watershed authority itself? A part of the answer is to be found in the long time span the developmental programs will require. Most of them will take at least a whole human generation to complete even the primary engineering works. Moreover, these works cannot be wholly projected from the beginning; as they

progress, their collective effects will have to be studied, and the tentative program subjected to modification. Moreover, as population increases and industrialization becomes more intensive, the realm of intelligent planning will widen rather than diminish.

There will, therefore, be no lack of time for the orderly debate and consideration of plans as the projects unfold. While retaining intact the powers of decision and action that have made the TVA so effective, it should be possible, without losing the great advantages of this modern form of governmental corporation, to attach to any watershed authority a carefully defined and empowered Watershed Congress made up of representatives of local and functional groups that have a vital interest in the plans and decisions of the authority.

Would such a body, deprived of powers of decision, be anything more than a make-believe form of democratic participation? If we consider the subject matter with which it would deal, the answer is a strong affirmative. It is not proposed that the Watershed Congress replace the technical planners, but that it review and debate their plans in the light of local and regional interests, and approve, dissent, recommend, or if need be protest to Congress. For, as the developmental plans unfold, there will be powerful conflicts of interest, as between communities, economic groups, and States. Thus, on the Missouri River, the difference between a 7-foot and a 9-foot navigation channel, a question of vital importance to downstream navigation interests, would deprive upstream irrigation interests of large volumes of water that could open up new agricultural lands. It seems clear that the point at which to begin to adjudicate such conflicts, as well as to enlist public interest in various alternative possibilities, is at the planning stage; and that these functions, instead of being discharged merely by informal proceedings, could be formalized in a democratic body recognized by Congress and truly representative of the valley peoples.

Such an advisory body would have a relation toward the new type of government corporation somewhat analogous to the relation of collective bargaining to the industrial corporation. And just as collective bargaining and the new institution of labor-management committees have been of enormous benefit to labor, to industry, and to the nation during the war, so a popular collective-bargaining agency attached to the valley authorities would aid rather than hamper its activities. And it would give to the people of the valleys a living voice and part in shaping their social and economic destinies in a way far more authoritative, organic, and effective than the methods of informal and optional consultation.

Such a device would also greatly assist Congress. These conflicts of interest have to be adjudicated at some stage, and as planning is now organized, the task of adjudication rests largely on Congress. Congressional Committees are ill equipped to adjudicate the details of such complicated plans, and their labors would be greatly lightened if these plans reached them with the maximum of agreement by the people and communities directly affected. It would then remain for Congress, besides passing on the desirability of agreed-upon projects, to adjudicate only the still unsettled conflicts between the Authority and the Watershed Congress. The alternative is to give the Authority officials enormous powers of decision, without a popular check and accounting, except for a loose and long-distance supervision by Congress.

A formal Watershed Congress need not and ought not to close all the innumerable avenues to citizen cooperation in planning and executing the developmental program. For the task of energizing the valley peoples to make the most of their resources and their opportunities can be achieved only in the degree that individuals, groups, and communities bestir themselves and carry their share of the load. The healthy precedent set by TVA, of making contracts with local agencies and groups to undertake specific phases of the valley program, could now

begin to be more definitely formalized in the basic legislation. Democratizing our economy, giving all people a fair access to the higher cultural goods of civilization, is not the responsibility of any managerial elite, governmental, industrial, or technocratic. It is the right of the people themselves to control and develop their own economy and their civilization. Their chosen managerial advisers are their servants, not their masters, for there is no mystery in modern technology which ordinary men cannot grasp and turn to their use.

THE COORDINATION OF RESEARCH

Another point at which local people, through such institutions as colleges, universities, experiment stations, and research institutes, could have an effective voice is in developing a carefully coordinated and global program of research in the industrial, economic, social, and land-use problems of the valley. For if unified development is to be the goal, the research underlying such a development must be articulated in a way to leave the minimum of gaps and guesses. The excellent report of the National Resources Planning Board on the Arkansas Valley proposes the creation of a research council as an auxiliary to the proposed Arkansas Valley Authority, whose function would be to stimulate and coordinate research programs of existing agencies and provide facilities for additional research. An orderly development of resources, in a way to assure permanence to the economic base, will require not only far more research than exists under an exploitative economy, but research that is planned and fitted together into a reasonably coherent whole.

EXECUTIVE DEPARTMENTS AND WATERSHED AUTHORITIES

The widespread adoption of river valley authorities will raise a basic issue touching the fundamental structure of the

executive branch of the Federal government. Reduced to its elements that issue simply is this, Will the authorities displace the Federal field agencies working on problems that come within the scope of the authorities themselves? Will the authorities become self-contained arms of government, moving in and possessing the field to the exclusion of other Federal agencies? If they were to do so, it is obvious that the governmental departments concerned would lose a substantial portion both of their policy-making and operational functions.

To assume that the authorities would quietly replace existing governmental agencies would be grossly to oversimplify a difficult problem of public administration and even more to underestimate the strongly entrenched power of existing departments and bureaus, with their records of achievement, their large staffs of trained personnel, their annual budgets, and the greater or lesser degree of good will they have built up in Congress and with the public. These agencies have not only important executive powers, but they also have great influence on the formation of public policy and legislation.

Valley authorities are not inherently incompatible with our existing departmentalized form of government; but nevertheless a total attack on the great engineering enterprise of land reconstruction, flood control, and river development will require a conscious reconciliation of these two forms of administration, which in the long run will require some drastic overhauling of governmental administrative machinery. This will become evident if we glance at the complicated maze of agencies engaged in various aspects of land and water control.

The entire field of agriculture, conservation, flood control, and natural resource development is parceled out among a great multiplicity of governmental agencies which in their present form, individually and collectively, are incapable of dealing with the broad problem that confronts them except in fragmentary and partial ways. The indivisible interrelations among the different aspects of land and river reconstruction

PLATE 15. Safeguarding soils and rivers requires conservation of whole watersheds.

Upper. Extensive area of contour-cultivation and strip-cropping in Texas.

Lower. Spaced contours on over-grazed range land in Idaho designed to put rainwater into the soil.

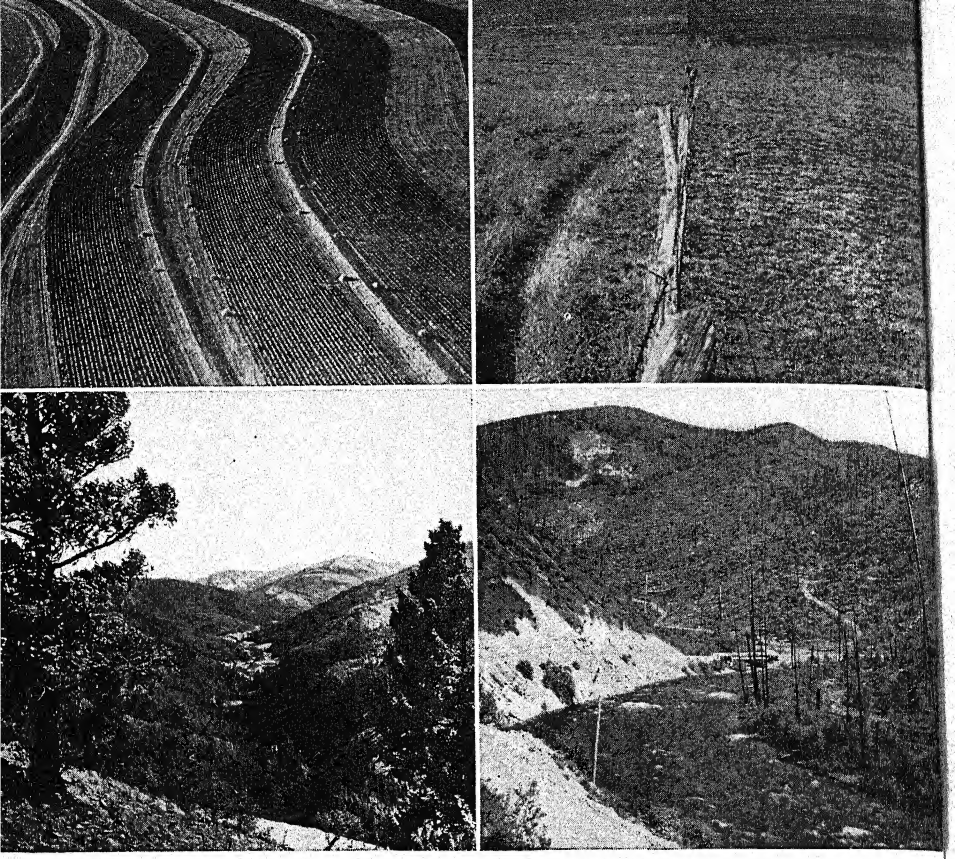

PLATE 16. The conservation of agriculture, range control, and forest management are the trilogy for safeguarding lands and rivers and recreating the broken harmony of nature.
Upper left. Strip cropping on terraced land.
Upper right. Good and bad range management.
Lower left and right. Good and bad forest management.

demand unity, coherence, and coordination among the agencies that deal with them. No mere reshuffling of bureaus will do the trick. We need a fresh and bold approach. This chapter does not deal with the intricate minutiæ of this complex problem, but rather with key mechanisms for an integral land and water conservation program round which reorganization of governmental activity may gradually take form.

In their historical growth, the many Federal agencies dealing with agriculture, land use, and flood control originated as modes of attack on special aspects of the total problem. They are a succession of historical accretions that took form with little relation to an over-all pattern or concept. This was natural. It is only in recent years that such an over-all concept of land and water conservation has emerged. Now it is clear that a new type of streamlined administration must be created to deal with it.

CONFUSION AND CONFLICT OF SUPERNUMERARY AGENCIES

Without calling the long roll of Federal agencies that deal with land and water resources, it is indicative to note that there are at least a dozen bureaus each concerned with a segment of the forest problem. The War Department, the Reclamation Service, and the Federal Power Commission have primary interests in river development. In the Department of Agriculture, there are over twenty separate bureaus each working on some one segment of agriculture. And in addition the Reclamation Service, of the Interior Department, deals independently, and quite apart from general agricultural policy, with the important segment of irrigation agriculture. Numerous bureaus in different departments are charged with the administration of public lands. In Congress likewise, numerous committees deal with parts of the total problem. Not infrequently these committees display the same qualities of jurisdictional competition that are so rife among executive agencies.

This splitting up of functions and responsibilities inevitably means dispersal of energy, fragmentary effort, the lack of common strategy and policy, and often also destructive competition and antagonism. It also produces single-tracked minds that fail to see their job in the broad and complex technological and social setting as a whole. Integral programs become impossible. Despite the advances on some conservation fronts, it is fair to say that we have no administrative machinery capable of developing a broad, complete national conservation program adequate to halt the downward trend of our natural resources and our civilization.

If we intend to rebuild this continent into a fruitful, beautiful, and dignified dwelling-place for endless generations of free men, if we are to use our resources to release men from poverty and ignorance in order to build an enduring, vital civilization, we must summon the will, the courage, and the creative energy to design democratic social mechanisms commensurate with this great end. A slipshod and incoherent maze of competitive, conflicting agencies, many of them primarily bent on maintaining their bureaucratic vested interests at all costs, quite obviously cannot do this job.

BEGINNING WITH REGIONAL COORDINATION

The TVA was designed to do a unified job of planning and development at the regional level. At this level, among the old-line agencies, the confusion and dispersal of government effort are acute.

Practically every bureau in every department that deals with some phase of the land problem has its own series of regional offices. These regional offices are not even geographically concentrated, let alone institutionally coordinated. Moreover, they are, so to speak, colonial dependencies of Washington, having little power to act or decide without approval from the central office.

There is no easy or simple solution of the potential jurisdictional conflicts between watershed authorities and the existing old-line agencies. In the TVA act, Congress merely touched on the answer in general terms. It authorized the Authority to request aid from other government agencies and directed it to use that aid insofar as practicable. It further authorized the President to direct other Federal agencies to aid the Authority. Probably Congress, scenting the complexity of this problem, preferred to let TVA experiment with it before attempting a more definite solution. TVA experience does, indeed, point toward a partial solution. In some phases of its work, it has invited Federal agencies to cooperate with it, under contracts of agreement, just as it has invited States, counties, municipalities, and other agencies to share responsibility. In other fields, it has built up its own staff, especially in planning, engineering, and forestry. Yet, as the legislation now stands, the TVA or any other Authority built on the same model could and might elect to build up a complete, self-contained regional administration that would either displace or ignore the executive departments.

This jurisdictional question is far less acute in the engineering field than in the broad and complex field of land conservation and upstream engineering. A watershed authority might elect, as TVA has done, to design and construct its major engineering works, or it might delegate all or part of that function to existing agencies like the War Department or the Reclamation Service. But in the field of conservation, no watershed authority can reach its goal without the effective collaboration of such Federal agencies as the Forest Service, the Grazing Service, the Fish and Wildlife Service, the Indian Service, the Farm Security Administration, the Agricultural Adjustment Administration, the Farm Credit Administration, the Extension Service, and above all the Soil Conservation Service. The Forest Service, Grazing Service, and Indian Service together administer approximately 375 million acres of land

(almost a fifth of our entire land surface). The National Forests clothe the mountainous headwaters of many of our great rivers. The Grazing Districts and Indian Reservations control crucially important grass-lands in the Great Plains and intermountain plateaus of the West. Equally or more important, the Soil Conservation Service, in cooperation with 46 States, is organizing a nation-wide system of self-governing soil conservation districts to combat soil erosion on our farms and range-lands. There are also important State conservation and land administration agencies.

ORGANIZING TOTAL WATERSHED CONSERVATION

There are two broad aspects of developing complete watershed conservation programs. One is to define the functions of existing conservation agencies within the field of watershed authorities. The other is to lay the necessary legislative foundation for a systematic and thorough conservation program proportional in its scope and effectiveness to the engineering side of watershed development. Legislation creating new authorities should be as specific in setting up the organization and the money for a complete conservation and upstream engineering program as it is in setting up the organization and the money for dams, levees, hydroelectric plants, and transmission lines. It should authorize and direct the valley authority, in cooperation with Federal and State conservation agencies, to plan a complete conservation program and to recommend the necessary appropriations and any additional needed legislation, Federal or State, to carry out such a program. Moreover, as pointed out later, Congress should take steps, even in advance of the creation of new authorities, to fill some very serious gaps in conservation legislation, notably in forestry and upstream engineering. The solution of the potential jurisdictional conflict between authorities and executive departments, then, seems to lie in the direction of more clearly defining and ex-

tending, in the basic legislation, the present TVA practice of making contracts with existing agencies, while setting up at the same time a process for the simplification, coordination, and fusion of these agencies themselves.

The solution here proposed is a realistic compromise, but a compromise that will make it possible to move steadily in the direction of an integrated regional and national administration in the field of natural resource development. For the contract device, made mandatory and clearly defined by Congress, would bring the functional agencies into the orbit of the overall policy-making and planning of the watershed authority, while giving them a voice in policy and planning. In return, the functional agencies would have to surrender some of their "sovereignty," a thing that government bureaus are loath to do. Yet they would gain by being geared into and having a definite responsibility in a thoroughgoing developmental program with adequate resources for doing a first-rate job. A demonstration of unified governmental administration at the regional level would be a contribution of first importance to the science of public administration and would throw much light on the vexed problem of governmental reorganization and simplification in the broad field of agriculture, conservation, and flood control.

GROUPING THE FUNCTIONAL AGENCIES UNDER THE AUTHORITY

In order to develop a land conservation and upstream engineering program throughout the given watershed, the basic legislation should contain a strong declaration of intent by Congress that it is the function and duty of the Authority to bring about the conservation and good management of all land and water resources, public and private, throughout the watershed; that to this end the Authority is directed to enter into contracts of cooperation with the appropriate Federal, State, and local agencies; that the Authority is empowered and

directed to review the programs, appropriations, and policies of Federal cooperating agencies as to their adequacy for the broad ends sought, to report to Congress and make recommendations thereon, and to advise and contract with the States as to their own appropriate fields of activity. In the public-land States, the Authority should be empowered to determine the grazing capacity of the public lands and to promulgate a uniform policy of reducing the numbers of livestock grazing such lands to a safe carrying capacity, as a measure of protecting the engineering works from destruction by siltation. In short, Congress should clothe the Authority with the power and the means to bring about a united front and a comprehensive, coordinated conservation program by all the agencies involved in the total task.

Under the Authority's general manager, there could well be two assistant managers—one serving as chief engineer for mainstream engineering, the other as chief conservationist in charge of upstream engineering and land conservation. The chief conservationist would have a small staff for the over-all planning of broad conservation strategy and for inspecting the activities of the functional agencies. Attached to the chief conservationist would be a Conservation Council made up of representatives of Federal and State land administration and conservation agencies. The purpose of this Council, acting through the Authority, would be to formulate and carry out a coordinated program of land management, public and private, designed to halt erosion and rapid runoff and to rebuild natural resources to their full productivity, and to join forces with each other and with the Authority to obtain appropriations adequate to their responsibility in the total flood-control program.

Even more important in bringing about a coordinated conservation attack would be to designate the Soil Conservation Service as the over-all planning and operational branch for land conservation and upstream engineering, under a general

contract with the Authority. Among the Federal functional agencies, the Soil Conservation Service would thus be *primus inter pares*. The reasons for giving that Service the leadership of the whole field are compelling. What the TVA has been to integral river development, the Soil Conservation Service has been to integral land conservation and upstream engineering. It has developed an integral philosophy and technology of land and water management and flexibly applied them, on a very large scale, to every type of soil, topography, and climate in the United States. In the organized soil conservation districts, it has created an amazingly successful democratic mechanism of cooperation for land reconstruction. Integral flood control and river development are doomed to defeat unless the work of the Soil Conservation Service and its allied districts is rapidly extended to all the watersheds of the United States.

THE LEADERSHIP IN CONSERVATION

The Soil Conservation Service, as one of its two main jobs, should be empowered to plan all the diversified works classed as upstream engineering, the purpose of which is to apply to the small tributaries or headwaters the same integral concepts of flood control that are applied, on a larger scale, to the main streams. These works include minor dams and reservoirs, stream-bank protection, the control and filling of gullies, the revegetation of denuded soils, water-spreading dikes, firebreaks, and similar works for the public benefit which cannot be financed, at least entirely, by private land owners. To achieve these works, it would be necessary to set up and finance a conservation works corps. The execution of these works on various categories of public land could be delegated to the appropriate administrative agencies.

The second main task of the Soil Conservation Service would be the rapid extension and staffing of the soil conservation

districts. Forty-five States have adopted the standard soil conservation act at the request of the Federal government and almost 1300 self-governing districts have been created to instal the beautiful new conservation technologies. Yet, in pursuit of the shortsighted fallacy of spending billions on dams but little on land conservation, the Soil Conservation Service and the districts are starving for enough funds to train and employ the necessary technical advisers to aid farmers in mastering the new agriculture. While Congress debates the spending of $1,000,000,000 for dams and other works in the Missouri Valley alone, the Soil Conservation Service receives a niggardly $25,000,000 a year to finance its entire work throughout the United States, including all the soil conservation districts. To permit this vitally energetic soil conservation district movement to die of inanition would be to destroy the most important agricultural revolution in all history, to doom our soils to destruction, and to defeat all efforts, however extravagantly financed, to control our wrathful rivers. The Soil Conservation Service and the districts should be provided with the funds and the technicians to complete its nationwide program of soil conservation in the next ten or twelve years. This extension should not wait on the creation of authorities; it should, in fact, keep well ahead of them so as to reduce erosion and siltation as a measure of protection to the engineering works.

ENDING FOREST DEVASTATION ON OUR WATERSHEDS

Even with the full extension of the soil conservation districts, there will still be a large and dangerous gap on the conservation front—namely, the continued destructive exploitation of the great bulk of our private forests. The investment of huge sums on river development will be unjustified unless it is accompanied by a thoroughly effective attack on the needless social evil of forest devastation. Well-managed forests

are the best of all soil- and water-holders and a perennial source of industrial raw materials. Soil erosion and deforestation—twin and almost universal evils throughout the United States—not only make flood control impossible, but reduce to futility all concepts of "full regional development." The competent technical management of forests is indispensable for the control and protection of navigable streams. Consequently, under the broad doctrines of modern constitutional law, the Federal government has the constitutional power to intervene in private forest management where necessary to protect navigable streams.

Adequate laws for regulating private forests are many years overdue. The present trend for great river-control works makes them immediately imperative. There is urgent need for a comprehensive Federal statute, which would define broad standards of technical management required to keep our various forest types productive and would then lay down the terms under which the Federal government would cooperate with the States in carrying out and enforcing State statutes to prevent forest deterioration and destruction. European experience over the past century or two, combined with our own long and tragic history of deforestation, clearly proves that the permanent technical management of forests for watershed protection and continuous timber production can be assured only by a sufficient degree of public regulation of timber harvesting to maintain forests in a vigorous, well-stocked condition. This regulation can and should be democratic and participative. One of the basic requirements of such State laws would be the setting up of technically staffed forest management districts, with elected boards of supervisors, to assist forest owners in organizing forest management up to the requirements of the State regulatory laws. Failing effective State legislation, the Federal government would reserve the right to intervene directly in the management of private forests vital to watershed protection. This legislation is particularly necessary in the

large commercial timber holdings. In the farming regions where soil conservation districts already exist or will be organized, the standard State soil conservation district acts need amending to give more emphasis to the management of farm woodlands, which aggregate 150 million acres out of our total area of 350 million acres of private forest-land.

The time to bargain with the States over effective forestry laws is while the great flood-control programs are in the making. The bulk of the money for these construction projects will be furnished by the Federal government. It is therefore fair to ask the States, as a condition of sharing in the enormous benefits of flood control, to enact and enforce effective forestry legislation and also to contribute financially to the rapid upbuilding of the soil conservation districts. Neither the Federal government nor the States can make a greater contribution to flood control or to the permanent prosperity of America than by the universal extension of competent management to our entire land surface.

PUBLIC LAND ACQUISITION FOR FLOOD CONTROL

The drive for nation-wide flood control also dictates a very substantial increase in public-land ownership and management for watershed protection. There is a vast aggregate area of cut-over forest-land, as well as eroded submarginal farm and range-lands, on which erosion can be halted and productivity restored only under public ownership and management. Such lands, stripped of most of their vegetative cover, subject to continuing overuse and abuse, will remain a menace to flood-control programs until they are taken over and reconstructed by public agencies, Federal, State, and local. As the primarily responsible agent in flood control, the Federal government should take the lead in organizing a Federal-State forest and submarginal land acquisition and development

program. At the same time, there should be a uniform provision applying to Federal public lands for a fair reimbursement to the States and local government units in lieu of the property tax. Unless this issue is equitably settled, the loss of tax revenue will continue to be a strong argument against the public acquisition of deteriorated lands whose reconstruction is an essential part of flood control.

OVERGRAZING ON THE PUBLIC LANDS

In many of the Western States, the public lands—especially the National Forests and Grazing Districts—cover extensive strategic land masses of decisive importance in flood control. On many of these lands, overgrazing is still prevalent, with consequent devegetation and erosion. Moreover, this overgrazing is closely associated with the administrative practice of granting large grazing preference rights, which over a long period threaten to become vested rights or servitudes that will make conservative public land management difficult. As a part of broad flood-control legislation, there is need for a declaration of Congressional policy to bring the grazing on these public lands down to the carrying capacity of the range, through an equitable system of reduction in preferences. Before the public lands were brought under administration, many of them suffered severely from overgrazing, unregulated logging, and fire, and still show the scars from these abuses. Not only for flood control, but for the full economic development of the public lands there is need for a more adequate investment to build up their productivity. The Civilian Conservation Corps did a vast amount of work in improving the public lands, but much remains to be done. Here again, as part of the river development construction program, there is need for a systematically organized and financed conservation works corps.

TOWARD REGIONAL AND LOCAL SIMPLIFICATION

It will probably be objected that the design for a valley authority here proposed is overcomplicated. This objection, however, is more apparent than real. For the proposed design recognizes two basically important and inescapable facts. One is that democratic participation in the vital decisions of an Authority will emerge, no matter what the precise legalistic form of the Authority may be, for the simple reason that in a democracy the people whose vital interests are affected by administrative decisions will insist on being heard. The plan here suggested would recognize that democratic fact in advance and set up an orderly method for adjudicating conflicts of interest. In the long run, a truly "authoritarian" Authority would be self-defeating, since democracy insists, as one of its basic privileges, on the popular power to review decisions and to hold functionaries responsible for their acts. The vigorous growth of democracy will hinge on the capacity of the people to obtain and maintain control over the development of modern technology for social use.

Another basic fact is that modern government is complex because modern society is complex. While the plan here proposed recognizes this complexity, it also moves toward simplification of government. Monolithic, all-powerful, self-contained regional authorities would ignore the fundamental complexity of human society and government. The TVA was an enormous stride toward simplification of government, yet the TVA has never assumed that it was a complete substitute for all other agencies of government, Federal and State. On the contrary, it has used whatever agencies were ready at hand to carry a part of the burden.

The design for an Authority here proposed would carry TVA a considerable step forward by bringing numerous governmental administrative agencies formally into the Authority

framework. In this way, the valley Authority's power would be greatly expanded; for if we admit that the basic function of the Authority is integrative, then it is clear that this function will be far more effectively exercised if it brings all the agencies of upstream engineering, conservation, and land-use development into its orbit. Moreover, as the Authorities gain experience, their integrative function will almost inevitably lead to a reorganization and simplification of the numerous agencies devoted to agriculture and land development. It seems highly probable, for example, that the democratically organized soil conservation districts will ultimately become the recognized unit through which many types of public agricultural service, from erosion control to credit, will function, and will be the local mechanism for the much-needed simplification of these services. The first step toward such simplification is the integration of these agencies within the framework of the regional Authority.

By way of contrast with an all-out attack on upstream engineering and conservation, we may usefully consider the TVA conservation program, which is inadequate both in scope and in methodology. In part, this is due to the vagueness of the basic TVA legislation in its treatment of the conservation part of flood control; in part, it is due to the absence of adequate Federal and State forestry legislation around which to build up an effective forestry program; and in part, it is due to the failure to make use of the most important of all erosion control mechanisms, the soil conservation districts. Early in its career, before the conservation districts were initiated, TVA elected to cooperate with the State agricultural extension services in building up its agricultural and land management program, and it later failed to take advantage of the soil conservation districts. As a result, soil conservation districts are virtually non-existent in the Tennessee Valley, though they have been highly developed in the surrounding regions.

This choice has been unfortunate. While the TVA demon-

stration program has produced important results, especially in the use of fertilizers manufactured at Muscle Shoals, it has failed to use the magnificent integrated technologies of soil conservation perfected by the Soil Conservation Service and the dynamic energy of the soil conservation districts to put these technologies into practice throughout the Valley. Thus, paradoxically, the modern, streamlined TVA is lagging far behind the rest of the South in its attack on erosion; and, for the protection of its huge investment in engineering works, is employing inadequate land management techniques and is ignoring a thoroughly tried and proven mechanism of social action.

The setting up of adequately staffed soil and forest conservation districts will require much more money than the meager sums TVA is now devoting to its erosion control and forest conservation program. The conservation program needs to be brought into focus and proportion with the river development program. The TVA has an investment of almost $800,000,000 in dams, navigation, and related improvements, whereas it is spending only $250,000 a year on forestry and erosion control.

THE NATIONAL COORDINATION OF VALLEY AUTHORITIES

If we are moving toward a nation-wide system of valley authorities, the need for a national coordinating and planning agency will be inescapable; otherwise, we should be confronted with unbridled and cutthroat regional competition and log-rolling. Quite naturally, under the experimental TVA Act, the Authority was required to report directly to the President and to Congress. However, with a multiplication of authorities, there would assuredly be the need for a central national coordinating and planning agency at Washington; for neither Congressional Committees nor the Chief Executive has either the time or the technical facilities for the adequate review of

the complex, detailed, technological, industrial, social, and economic factors in such a stupendous enterprise of national development.

If the basic principle of the regional authority is integrated planning within its region, and if the corporate form of Authority is to retain its unique advantage of freedom from detailed supervision from Washington, then clearly the main function of the national coordinating agency would be that of planning on a nation-wide scale rather than the conventional, detailed, long-distance, departmental "supervision." It would inventory our natural resources. It would promote legislation, Federal and State, for husbanding those resources. It would pass on plans and budgets of the authorities, weighing the claims of one region against another. It would study and recommend to Congress the reorganization of functional government agencies involved in regional watershed development. It would deal with problems of interregional competition and with industrial decentralization.

Such an agency would fill a much-needed gap in American government. Neither Congress nor the Executive has any adequate facilities for nation-wide planning for the development of natural resources. One great advantage of multiplying valley authorities is that it would force us to face once and for all the need to set up a system of national planning. We have been reluctant as a people to give real recognition to planning, presumably because planning, in the modern broad social and economic sense, has unnecessarily acquired the connotation of authoritarianism. There is nothing inherently undemocratic in planning provided its mechanisms and goals are democratic. Moreover, in the long run democratic planning can get much further than authoritarian planning, since it can enlist the full support of the people.

If effective national resources planning is to be done on the national level, it must be done by an agency with something stronger than recommendatory power. Most of our organized

planning has been done by agencies with little or no authority to make decisions and to act. The former National Resources Planning Board is a case in point: its functions were almost wholly advisory and recommendatory. TVA has fused planning with action at the regional level. That is because it had wide power over the money and men at its disposal. For effective, over-all nation-wide planning of river valley development, the agency clothed with general coordinating power over regional authorities would need a broad grant of power from Congress especially in adjudicating conflicts of interest, in approving broad developmental programs, and in modernizing and streamlining government. Whether the central agency is an existing department reorganized for this specific purpose or is a new agency created by Congress, it should have a policy board of directors made up of representatives of both the Executive and of Congress. For the system of authorities represents a great delegation of power by Congress. Moreover, unless Congress wishes to delegate all planning functions to the Executive, it needs to create and help direct a stable, continuing, scientific body, auxiliary both to Congress and to the Executive, whose function will be to bring organized knowledge to bear more effectively on legislation and public policy.

II

Agricultural Science and Education

IT IS not to be inferred from anything set forth in this book that the science and art of land and water conservation are complete and finished, and that all we have to do is to apply them. The broad underlying field of soil science, for example—especially in its bearing on maintaining soil fertility and the relation of soil fertility to nutrition—is only well started on its complex task. The same may be said of ecology, the science of the complex interrelatedness of plants, animals, and soils. A vast amount of research remains to be done on the hydrology of our river systems. The techniques of farm, range, and forest management need to be refined and perfected. Yet in these and many other fields pertaining to conservation, science has made notable advances and we are in no position to fall back on the time-honored excuse for inaction: that we do not yet know enough about these complicated matters to go forward with a large-scale, practical program of scientific land and water control.

It is outside the scope of this study to catalogue the significant advances made in the many sciences pertaining to conservation or to chart the broad fields remaining to be explored. It is, however, very pertinent to examine the general relation and attitude of agricultural science and education to the basic problem of conservation.

The stabilization of the world's soils, waters, and rivers requires nothing short of a revolution in agriculture and land

use. Only by the full development of conservation techniques on all land is it possible to make agriculture permanently prosperous, to assure an abundant food supply, and to develop our water resources and river systems as allies of a dynamic civilization.

Conservation must, therefore, become the basis of agricultural policy and the integrating concept around which agricultural science and education must be reoriented. This is not to infer that conservation constitutes the whole of agriculture or that it exhausts the problems with which agricultural policy, science, and education must deal. But it does mean that agricultural policy, science, and education must take their start from and build their superstructures on the ecological principle of the interrelatedness and interdependence of the factors of the natural environment.

CONSERVATION ISOLATED FROM AGRICULTURE

Partly because of its late arrival on the scene, partly because of excessive departmentalization of scientific work in the government, universities, colleges, and research institutions, conservation is still a side-show in agricultural education and science, as well as in agricultural policy and flood control. The conservation group has existed largely apart from the agricultural group in public administration, in education, and in scientific research. The result has been a wholly inadequate emphasis on conservation in broad agricultural and flood-control policy. Still stronger has been the isolation of the conservationists from the flood-control engineers. This isolationism has been disastrous from the standpoint of achieving an integrated public policy on land and water conservation. Conservation has had to accept a subordinate position. Agricultural policy, in turn, has been preoccupied with the pressing short-range problems of agriculture, and has failed to come to grips with its basic problem—the preservation of the basic capital

asset, the soil. And flood control has been struggling with the superficial symptoms of our sick rivers rather than the basic causes of that sickness—soil destruction, overgrazing, deforestation, erosion.

This isolationism in the broad realm of man's relation to the earth and its resources is a part of the widespread compartmentalization of science, government, and human society under the impact of the nineteenth-century interpretation of nature and society. But science itself is undergoing a profound revolution. The emergence of the "field laws" in the new physics and the concept of the space-time continuum signifies a basic shift in science from preoccupation with the constituent particles and elements of bodies and systems to the laws of organization by virtue of which organized wholes achieve significance and value. Both the biological and the social sciences seem destined to be forced into the same path, since neither the realm of organic nature nor the realm of human society makes sense when treated as aggregates rather than organic systems.

Specifically in the domain of agriculture, land use, conservation, and flood control, we know enough to know that nature herself is not compartmented and that her forces constitute a unified, interacting whole. We know also, from our tragic experience in natural resource destruction, that human communities and societies, treated merely as unorganized groups, are incapable of achieving a basic harmony with the organized realm of nature. It is the function of the biological sciences to explain the laws of nature as a systematic whole, and of the social sciences to elucidate, by legislative experiment, the modes of cooperative human action capable of dealing with nature as an organized whole.

The TVA and the organized soil conservation districts represent revolutionary breaks with traditional administrative concepts in substituting unitary action for fragmentary action in dealing with natural forces and resources. Both these great

movements need a steadily growing supply of new types of minds—integrative minds, we might call them, for want of a better word, or whole minds instead of fragmentary minds. The delicately interacting forces of modern civilization can no longer be operated or controlled by mere groups of specialists, no matter how well "coordinated"; for the mere arithmetical summation of fragmentary minds does not produce an abstract whole mind or a set of true social ideas.

REORIENTING AGRICULTURAL EDUCATION

In the domain of agriculture, land use, conservation, and flood control, the experts, the scientists, the administrators, and the educators have a common meeting-ground in the unity of the soil-water-animal-plant complex. Agricultural education, in its broadest aspects, can be built on an ecological foundation and can subject the minds of its students to a basic unifying discipline and philosophy. For whether the agricultural student intends to become a practical farmer, an educator, an economist, a land manager, a public administrator, or an agricultural leader, he will remain ill equipped for his task, whether it involves a few acres or a continent, unless he grasps the underlying ecological principles involved in land destruction and natural resource conservation. Yet by and large, the curricula of the agricultural colleges are far from such a fundamental integration. The forestry and range management curricula are separate and distinct from the main agricultural curriculum, and the main curriculum itself makes no adequate provision for the basic ecological principles of conservation.

If we are to have adequate future leadership in rebuilding land use and flood control on the foundation of ecology, a broadening and integration of subject matter both for the general agricultural student and for professional students of forestry, range management, soil conservation, and hydrology is urgently needed. The expanding conservation program has

reached the point where the agricultural specialist, whatever his niche, must have a broad outlook on integral land management as a whole; in addition, we need an increasing force of broad-gauged land managers to organize the strategy of reconstruction of land and water resources.

The lack of trained manpower is, in truth, an important limiting factor in the rate of speed with which we are compelled to attack the breakdown of our lands and waters. The rapid extension of the soil conservation districts, the creation of a nation-wide system of forest conservation districts, and the setting up of numerous river valley authorities will require a very large increase in technicians and administrators with a thorough grasp of integral land management. This difficulty, however, is not insurmountable. The first line of assault is the revision of agricultural and engineering college curricula to permit the intellectual integration sketched above. But there is a further and more specific need. That is to provide post-graduate training for integral land managers and for researchers in integral land management to form the cadre for the extension of integral land management. These advanced programs should be worked out by the agricultural colleges and other schools, such as those of engineering and public administration, in cooperation with the public agencies responsible for the developmental programs, and should provide for a systematic alternation between academic instruction and operational field training. Such a program will not just grow up, in response to the law of supply and demand, but will have to be cooperatively organized by the schools and the government, in much the same way that war-training curricula have been cooperatively organized by the military departments and the universities. With such an educational program, the manning of the land management districts and the valley authorities could proceed systematically in the same way that an army expands—by using the cadre of highly trained professional personnel for the training of the subordinate per-

sonnel in cooperation with the colleges. Unless the recruitment and training of an adequate personnel is systematically organized in a way to keep abreast of the need, the large-scale attack on land and water reconstruction envisaged by the impending creation of numerous river valley authorities may be doomed to disappoint public expectations.

THE INTEGRATION OF SCIENTIFIC RESEARCH

The unitary nature of the soil-water-plant-animal complex requires the creation of a unitary scientific strategy to unravel its hidden and interrelated processes. This is only one aspect of the larger problem of organizing science to achieve its full potential social value. In the past, scientific inquiry has been marked by extreme individualism. Multitudes of specialists, working largely in isolation, have pursued their particular fragments of inquiry without relation to the whole field or without recognizing the necessity of organizing the whole field. The war has taught us that the systematic ordering and designing of research, with many scientific men doing their individual share in a large and systematic plan, can enormously speed up the progress of science.

The integration of research will mean that scientific men will more and more work cooperatively together on broadly designed research projects, under working plans that simultaneously attack the many facets of the aggregate wholes that constitute natural and social process. Broadly systematized research programs, voluntarily organized and operated by men and institutions cooperating under common concepts, strategies, and objectives, need not be "regimented." For the highest freedom is itself the by-product of order, and science can be released into new creativity by the principle of cooperative action. If, on the other hand, science continues to pursue its past trend of extreme individualism and if scientists fail to take the lead in organizing cooperative research, government

is likely to continue and increase its tendency in recent years to take over more and more research functions.

For the natural sciences, the unriddling of the subtler aspects of the soil-water-plant-animal complex offers an exciting cooperative intellectual adventure. The conservation, development, and utilization of the natural resources of whole regions must be built on a program of integrated research, covering a wide range of inquiries—physical, biological, hydrologic, economic, and social. The creation of watershed authorities should embrace the systematic organization of the existing research facilities and the creation of new ones for cooperative action, under democratic procedures. Such an attack can lay the foundations for a new earth and a new society. The agricultural sciences, and the corollary sciences involved in the physical, economic, and social reconstruction of watersheds, should become the intellectual vanguard of the legislators, administrators, engineers, agronomists, managers, planners, and land users who together have the responsibility of rebuilding the face of the land and reinvigorating the human communities dependent on the land and its resources.

12

Toward World Conservation

IF THE world's food needs are to be met henceforth, the nations of the world will not only have to put their own lands in order, but they will have to collaborate to discourage the kind of agricultural commerce that promotes soil depletion. The world's great common fund of knowledge and experience in scientific land management should be pooled for the benefit of all nations. A vitally important step in that direction was taken in the Final Act of the United Nations Conference on Food and Agriculture held in 1943. That report is pervaded with the recognition of the indissoluble connection between good land management and adequate nutrition.

"The types of food most generally required to improve peoples' diets and health," the Conference agreed, "are in many cases those produced by methods of farming best calculated to maintain the productivity of the soil and to increase and make more stable the returns to agricultural producers."

Noting the fact of world-wide malnutrition, the Conference recommended the general adoption of mixed rotational farming or crop diversification in place of the widely prevalent single-crop farming or monoculture, both as a means of providing better diets and of conserving and sustaining soil fertility.

"Soil erosion," the Conference declared, "has in the past destroyed or severely limited the utility of vast areas of land and will, in the future, unless checked, constitute the greatest

physical danger to the world's food production. Failure to conserve and control water supplies and to use them efficiently has, in many areas, precluded important potential increase in food production. To meet the food needs of the growing world population and to ensure high nutritional standards, all land in agricultural use or suitable for being brought into agricultural use should be adequately protected from erosion and from any other serious damage by various measures, including structural work and the insurance of satisfactory agricultural systems and husbandry practices. The conserving of land and water resources should be regarded as an obligation of governments as well as individuals."

Following this general declaration, the Conference recommended that each nation undertake a survey of soil erosion and water wastage as a basis for a concrete program of soil and water conservation in which individual farmers would be assisted in planning and carrying out suitable crop rotations and erosion control and water conservation measures. It also recommended that each nation establish adequate systems of rural adult education "to promote technical efficiency among producers, to develop understanding of rural problems, and to enrich rural life."

WORLD FOOD AND AGRICULTURE ORGANIZATION

In order to carry out its far-reaching plans for the world-wide improvement of agriculture, of soils, and of human nutrition, this United Nations Conference, through its Interim Commission, has drafted a constitution for a permanent Food and Agriculture Organization of the United Nations, to come into effect when ratified by twenty of the member nations. Among the main functions of this world organization will be the conservation of natural resources and the adoption of improved methods of agricultural production, the promotion of forest management, the promotion of research relating to nutrition,

food, and agriculture, the improvement of education and administration and the spread of public knowledge in these fields, the provision of adequate agricultural credit, and the formulation of international policies on commodity arrangements. To assist the nations in these great undertakings, the organization will be prepared to furnish technical assistance and to organize advisory missions.

The basic aim of the new world food organization is nothing less than to reorganize and modernize world agriculture to the point where it can meet the needs of human nutrition. This is a task of formidable size, when it is considered that two-thirds of the world's people are farmers, and that their full and intelligent cooperation will be needed in working toward the goal of scientific agriculture and full production. It is also clear that, beyond the merely educational aspect of modernizing agriculture, international commodity arrangements and planned national food production programs will require an unprecedented state intervention in agriculture, since they will involve the fundamental reorganization and reorientation of world agriculture. It is inconceivable that these vast undertakings can succeed unless farmers in every nation are organized into responsible cooperating groups, with competent advisory services.

ORGANIZING A WORLD ATTACK ON EROSION

This study has emphasized the urgent need of reorganizing the methods by which the results of agricultural science are made available to and applied by farmers. It has stressed the fact that farms must be planned and treated as organic, integrated units. The conservation of soil and water and the diversification of crops, as well as the adjustment of farm production to market demands, require the creation of a farm management advisory service to assist farmers in well-rounded, complete, long-range management plans. The safeguarding of

the public interest in the already badly depleted soil and water resources also requires the cooperative organization of farmers in order to make rapid headway in applying the complex technologies of soil, forest, and water conservation. This study has proposed the land management district, organized by law as a legal body-politic, as the fundamental unit of agricultural administration, not only in conservation but in credit, production controls, adult education, and other aspects of agriculture in which public authorities cooperate with farmers.

The new World Food and Agriculture Organization could make no greater contribution to the modernization of agriculture, to increased food production, and to the stabilization of the world's basic resources of soil, water, and forests than by promoting the world-wide adoption of the new soil and water conservation techniques and the democratic, cooperative organization of farmers on the general model of the American soil conservation districts. These recent developments in America have already attracted world-wide attention and interest; and the strong commitment of the United Nations Food and Agriculture Organization to world conservation and crop diversification makes it the logical agency to give other nations the benefit of the American experience.

TRAINING TECHNICIANS FOR OTHER LANDS

A first step in this direction has already been taken through bringing to this country about thirty agricultural technicians, mostly from Latin American countries, for several months' study and experience in the methods of combating erosion and organizing soil conservation districts. Training facilities have been provided by the Soil Conservation Service and the Indian Service. The countries represented were El Salvador, Haiti, Chile, Mexico, Venezuela, Paraguay, Argentina, Ecuador, Cuba, Brazil, Costa Rica, Peru, and China.

This training program might well be rapidly extended by

inviting all other countries affected by erosion to send agricultural technicians here for similar study. Among the countries that have critical erosion conditions, besides those mentioned above, are Greece, Yugoslavia, Russia, France, Belgium, The Netherlands, French Africa, South Africa, Ethiopia, India, The Middle East, Australia, and New Zealand.

Assuming a receptive attitude on the part of these countries, 250 foreign agricultural technicians could annually be trained in soil conservation, at an estimated cost of $750,000. Many cooperating countries would doubtless be willing to pay all or part of the cost of the training. The training of successive delegations of technicians could be continued until each country was satisfied that it had the scientific nucleus to attack its own erosion problem effectively.

A second step toward world conservation would be to offer the services of experienced American soil conservation technicians to cooperating countries. A preliminary estimate indicates the need of about 300 such technicians at an annual cost of about $2,400,000. These experienced experts, going to foreign countries by invitation as advisers, would find ready to hand the technicians previously trained in the United States, who would have the great advantage of knowing the native agricultural traditions, institutions, and popular psychology. These advisory experts could assist governments in organizing surveys of soil erosion and water wastage, in drafting conservation legislation, in setting up demonstration areas and conservation districts, and in formulating research, educational, and training programs.

Both these steps would assist nations desirous of reconstructing agriculture on a permanent stable basis. In fact, the American technicians and their native co-workers should occupy an important place in whatever general agricultural rehabilitation service is set up to cope with agricultural disorganization and hunger. Conservation must become the core of world agriculture.

CURBING THE EXPORT OF SOIL FERTILITY

But even these steps are not enough. International agreements must be set up to discourage the world traffic in soil-depleting crops. Nations should be chary of exporting their own soil fertility. It is not to be expected that world trade in agricultural products will be suspended. But we should move in the direction of discouraging the export of foodstuffs that cause soil depletion. International commodity agreements should take note of the fact that much of the surplus crop production that makes the quota system of export necessary comes from soil-depleting, one-crop farming, and that a real solution of the surplus problem demands diversified cropping.

The new agriculture will greatly alter international agricultural trade. Through conservation farming, with its necessary diversification, each nation, region, and locality will become more self-sufficient in agricultural products. This is not autarchy. It is the only means by which soils can be safeguarded and a high standard of nutrition can be provided. It is a fortunate circumstance that the demand of the soil for diversified cropping in order to maintain soil fertility corresponds with the demand of the human organism for a diversified diet. It is this coincidence that makes conservation the clue to adequate nutrition and that will force world leaders to make conservation the keystone of world agricultural policy, indeed of world economic policy. There is no solution to the evil of increasing world-wide malnutrition and hunger and ultimate famine unless we meet and master the world soil crisis.

The nations will be safe from soil destruction only if they move toward a naturalistic agriculture and push diversification to the economic limit. Instead of subsidizing exports, it will be far safer to subsidize increased domestic consumption. During the past century the world's soils have become the victim of mechanistic concepts. Farms were turned into food

factories, farmers into food mechanics. The sense of the soil as a living organism largely disappeared, and with it, the soil. The farmer of the future must be a biologist and an ecologist, not a food mechanic. World agriculture must be established on biological and ecological principles that emulate nature's way of maintaining the dynamic soil-water-plant complex.

Index